NT, JANUARY 23, 1936

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FLIGHT

The AIRCRAFT ENGINEER AND AIRSHIPS

FIRST AERONAUTICAL WEEKLY IN THE WORLD : FOUNDED 1909

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King George V.

HIS late Majesty King George V won the love of all his subjects and the respect of the whole world. No monarch of recent times has been better beloved or more deeply mourned. Above all things, he was a good man, with the very highest sense of duty and service. He spent his whole life in the service of his many peoples, and to all of them he was a pattern and example of what a British gentleman ought to be.

He had no easy life. Had he been free to choose for himself, he would probably have preferred to spend his life as he began it, as an officer in the Royal Navy. But with the death of his elder brother, the Duke of Clarence, the call came to him to sacrifice his own tastes to public duty, and he never flinched from the sacrifice. In his reign there broke out the greatest war the world has ever seen, in which it fell to the British Empire to play a leading part. Through those four terrible years the calm, brave, self-sacrificing example of the King cheered the Empire through its trials and sorrows, and helped to give every man and woman strength to endure. To be King and Emperor during the war was a terrible ordeal for a man who loved peace and happy home life, and the way in which King George rose to his responsibilities during that crisis could not conceivably have been better done.

Vandyk

The reign of George V saw the birth of the Royal Air Force and of commercial air transport, two things which already promise to change the character of war and the organisation of peaceful life. Had there been no great war, the conquest of the air alone would have made King George's reign memorable in history. To no section of the world can air transport make a greater difference than to the widely spread British Empire. Before he came to the throne King George travelled widely throughout his future dominions, and after his

accession he moved his Court to Delhi to be there proclaimed Emperor of India. No previous King, and few other men, had more experience of the distances which separate the various lands of the British Empire, and none can have appreciated more keenly the boon which aircraft is bringing to all of them.

King George's death has left us all mourning, but greater than our grief is our admiration for a kingly life well lived.

The New King

In the midst of deep sorrow the Nation and the Empire greet the new King. He is a man who has already made his mark and gained for himself a world-wide reputation. Widely travelled, he has been described as "Britain's best Ambassador." Foreign observers have recognised in the Prince of Wales a man of mark, a man gifted with qualities which have already given him an established place in the world. It has often been said that his character closely resembles that of his grandfather, King Edward VII, who was universally recognised as one of the ablest men who has sat upon a throne in modern times.

In many ways the experiences of the new King have been unique. Not since George II has Britain had a King who has actually been in battle. Our new King won the Military Cross in the Great War, and his cool daring caused the greatest anxiety to those responsible for his safety. The War gave him a wonderful education, for it brought him in contact with all classes of his future subjects at a time when danger and suffering had brought to the surface all the best qualities of the British race.

Since the Armistice the Prince of Wales—he is still Prince of Wales, although he has now assumed a higher title—has travelled widely throughout the Empire, and sometimes in foreign countries. He is a ranch-owner in Canada; Australians have affectionately hailed him as "Digger." Once, speaking at a St. George's Day banquet, he humorously remarked "I am, among other things, an Englishman." That remark seems to give the key to his unique place in the world; he is identified with every section of the British Empire.

It has been said that the hardest position in the world to fill with success is that of Prince of Wales. It may safely be said that none has ever risen more whole-heartedly to the responsibilities of that position than our new King has done. Following the best traditions of his House, he has put duty and service above everything else. However fatiguing and irksome the duties, he has never shirked them. Yet, while following the beaten track of public duties, the new King has always displayed an originality of thought and of character. There has been individuality in every speech which he has delivered. His sense of humour is one of the minor points of his personality which have helped to make him tremendously popular.

Because of his character his taste for flying has been very helpful to the aeronautical movement. He took to it for purely utilitarian motives, because it saved him time and enabled him to do more work in a year with less fatigue. Then he began to like flying, and learnt unofficially to fly his own machines with considerable skill. His grandfather, probably for similar reasons, was an early patron of motoring, and again the new King has shown his likeness to King Edward VII. His example naturally made a great impression on many who had thought flying a very dangerous pursuit. It was typical of the man to patronise what is best in modern scientific progress, and to identify himself with the movements of the day. His flight to London last Tuesday sets a royal example.

Vandyk

King George, as Chief of the Royal Air Force, inspecting the Guard of Honour at Mildenhall during his review of the youngest fighting Service last July.

Vandyk

The New King in the uniform of the Royal Air Force.

The Outlook

A Running Commentary on Air Topics

The Human Element

MEMORIES of the early days of flying inevitably lead to a contemplation of the technical progress made during the last quarter of a century. Speeds have gone up from about forty miles per hour to more than four times that figure. Speed range has increased from the rather less than two to one of the early aeroplanes to as much as four to one. Aeroplanes are more stable, and much more controllable than they were. And yet, when all is said and done, the safety of the aircraft ultimately rests with the pilot. The human element is still a tremendous factor in the evolution of flying.

That Major Cooper, the Air Ministry's Inspector of Accidents, should find himself compelled, as a result of the most painstaking investigation of the Tatsfield accident, to the conclusion that the pilot was guilty of an error of judgment, to which bad weather contributed, and stalled the machine, will be the cause of nothing but sympathy and understanding. The foreman of the jury stated that no blame attached to the pilot, and indeed the conditions at the time were such that the accident might have happened to any pilot. Finding himself in a valley and flying towards rising ground, he did the only thing any pilot *could* do. In trying to get out of the valley he stalled the machine. The margin between clearing the ground and avoiding a stall, if any margin existed, must have been extremely narrow, and all flying folk will agree with the jury that no blame can be attached to the pilot, who was a man of very long experience.

The Heroic Days

FOR a few hours last week some of the pioneers of flying recaptured in reminiscence something of the glamour and adventure of the old flying days. Louis Paulhan and Claude Grahame-White, as recorded in this issue, were the guests of the Aero Club of France, and the "*Vieilles Tiges*," at a somewhat belated celebration of the twenty-fifth anniversary of the London-Manchester air race, won by Paulhan in 1910.

What memories are recalled by such names as Louis Bleriot, Louis Breguet, Henry and Maurice Farman, and Moore-Brabazon! Those were, indeed, heroic days. The aeroplanes were mostly contraptions built of sticks and string, their top speed was in the neighbourhood of forty miles an hour, and ailerons were not interconnected, so that while the machines were taxying they flapped about in the breeze. Engines that would run for two or three hours without breaking down were regarded as marvels of reliability, and their low power necessitated flying "all out" the whole time. Pilots were, for the most part, seated out in the open, with a gale blowing up their trouser legs and out behind their necks. But what fun it all was!

When the London-Manchester race was first announced there were many who considered it premature and foolhardy, and perhaps it was. But the race was flown and the prize won. The competitors were given twenty-four hours in which to complete the 186 miles, and that was barely enough, both Paulhan and Grahame-White doing a considerable amount of night flying. Think of it! Machines loaded to about four pounds per square foot and wallowing about in every gust and eddy that struck them; the difference between "power required" and "power available" almost nil; engines of very doubtful reliability; and forced landings to be made in the dark. The modern Super Drone would have seemed overpowered by comparison in those days. And yet serious accidents were relatively few, the reason undoubtedly being that landing speeds were in the neighbourhood of 25 miles per hour. The penalty for a mistake was not as heavy as it is now.

Lesson from a Rescue

TWENTY miles from the wireless masts and supply dumps at Little America, after 2,000 miles flying, the fuel supply in Lincoln Ellsworth's Gamma, *Polar Star*, gave out. Herbert Hollick-Kenyon, the British-born pilot, put the big Northrop down safely, and pushed on with Ellsworth to complete the journey by sledge. Their wireless failed, and they resigned themselves to the inevitable wait for rescue.

At the request of the Australian Government, the British-manned Royal Research Ship, *Discovery II*, sailed in December for the Ross Sea, carrying a Moth and a Wapiti of the Royal Australian Air Force. Ten thousand miles away, in Somerset, the Post Office wireless station at Portishead was keeping in constant touch with the ship as she made her way farther and farther beyond the Antarctic Circle. On Wednesday and Thursday last week conditions were such that Portishead could only receive and not transmit to her. The operator managed, however, on Thursday to pick up a code message to the wireless station at Awarua, New Zealand. *Discovery II* had arrived at the Bay of Whales and a man had been sighted. The Moth made the discovery; the man was Hollick-Kenyon. He was very fit; Ellsworth had a cold.

Thus we have one more demonstration of the general rule that the aeroplane, be it exploring or rescuing, or flying on its commercial, military or naval business, can be used to full advantage only in co-operation with other means of transport and communication.

Suiting the Customer

IF there is one type of aeroplane which Great Britain can build to perfection it is the general-purpose machine. For years now that class has enabled the Royal Air Force to maintain control over, watch, and assist in the development of vast areas of inhospitable country with pronounced efficiency and economy. The "G.P." bug has bitten hard and deep, and to-day a very large portion of the R.A.F. is equipped with small manœuvrable biplanes, all of one basic design, but used by squadrons undertaking bombing, fighting, army co-operation, fleet reconnaissance and general-purpose work. All of this stamps the design concerned as an unusually good one.

It appears, however, that while this country has been specialising in aircraft of this type, others, notably, of course, America, have been developing a different class to interest the export market, and seem likely to do good business in consequence. The sort of machine one has in mind is the fast, large, but relatively unmanœuvrable single-engined monoplane, first cousin to a commercial type, and able, in consequence, to carry a large disposable load for a longer range than the sprightly biplanes already mentioned, on very little more power. The fact that this type of machine does not make an efficient two-seater fighter, and that terminal velocity diving is not recommended, may not concern the customer.

Happily, we are not in such a bad position as we might well have been, for within recent months certain manufacturers have produced twin-engined types of similar power which should suit a large number of foreign customers in that they have a good range and carrying capacity linked with high performance. And they use no more power than the single-engined "jacks-of-all-trades."

THE D.H. DRAGONFLY

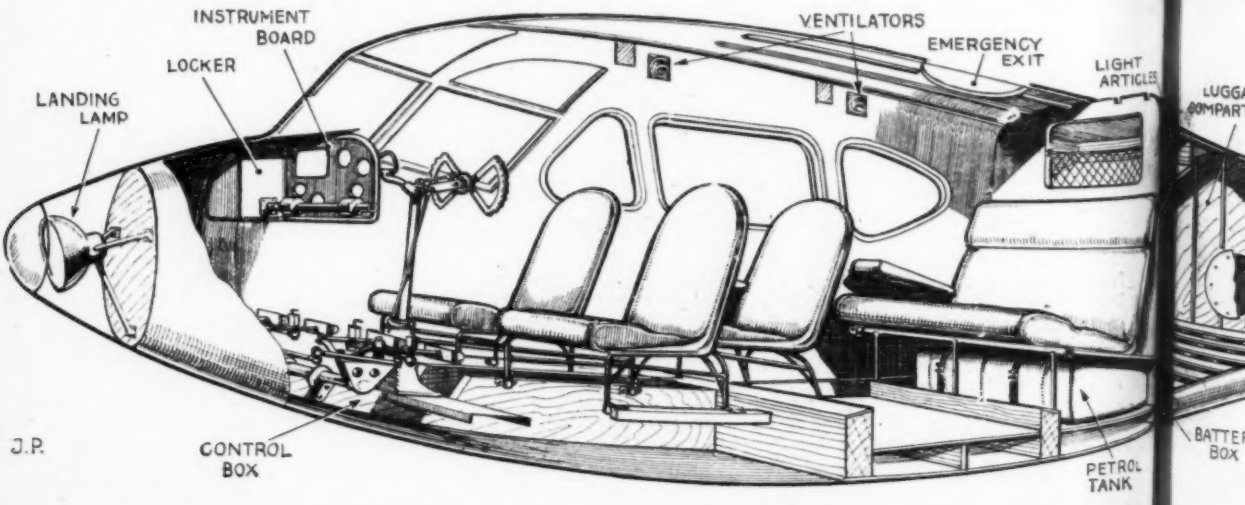
New Structural Methods Introduced in Latest De Havilland Production : Great Simplicity of Design Results in Economy of Parts : Very Complete Equipment Standardised

BEARING a strong family resemblance to the D.H.89 Rapide, the new De Havilland differs a good deal, structurally more than aerodynamically, from that successful machine. Like the D.H.89, the D.H.90 (or Dragonfly, as it will be known) is a twin-engined biplane of familiar De Havilland plan form, with the two engines and the undercarriage faired into the lower wing. The machine has, however, been "cleaned up" in different respects as compared with the D.H.89, and is a good deal smaller in dimensions, areas and weight.

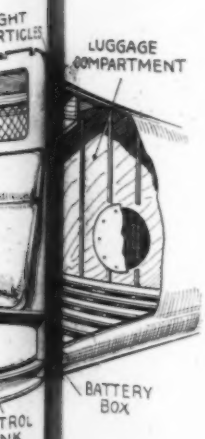
Of the changes made in structural design, those incorporated in the wing layout are most noticeable. Whereas the D.H.89 has two sloping struts from engine mountings to top of fuselage, two inner and one outer inter-plane strut on each side, as well as a diagonal strut to brace the undercarriage laterally, the new D.H.90 has but three wing struts on each side, and the undercarriage is full cantilever. Not only is a certain amount of drag saved in this way, but the number of parts and fittings has been considerably reduced, with a resulting gain in general simplicity.

The wing-bracing structure is interesting because of its unorthodox arrangement. There are no bracing wires in the inner bay, and those of the outer bay are in a single plane, although each lift and anti-lift wire is duplicated for safety. The double wires are, of course, placed in tandem, close together. The wing spars and ribs are of the type commonly employed in De Havilland aircraft, that is to say, of wood construction. The inner pair of inter-plane struts forms an inverted vee, meeting on a stout drag tube between the two main spars. The outer strut is a single one, also attached at its ends to the drag tube and not to either spar direct. Incidence adjustments are incorporated at the strut ends. The details are shown

Ample room everywhere and a noise level reduced to the neighbourhood of 70 decibels are features of the D.H.90 cabin. The accommodation provides for pilot and four passengers, one seated next to the pilot. Note the dual flying controls. An extra petrol tank of 25 gallons capacity is installed under the rear seat.



"Throwing it About": Mr. H. Buckingham gives the D.H.90 a thorough try-out above the clouds. (*Flight* photograph.)

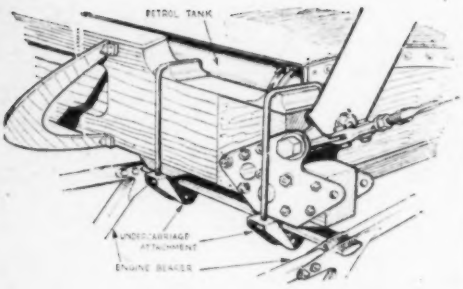


in the two sketches published on page 82.

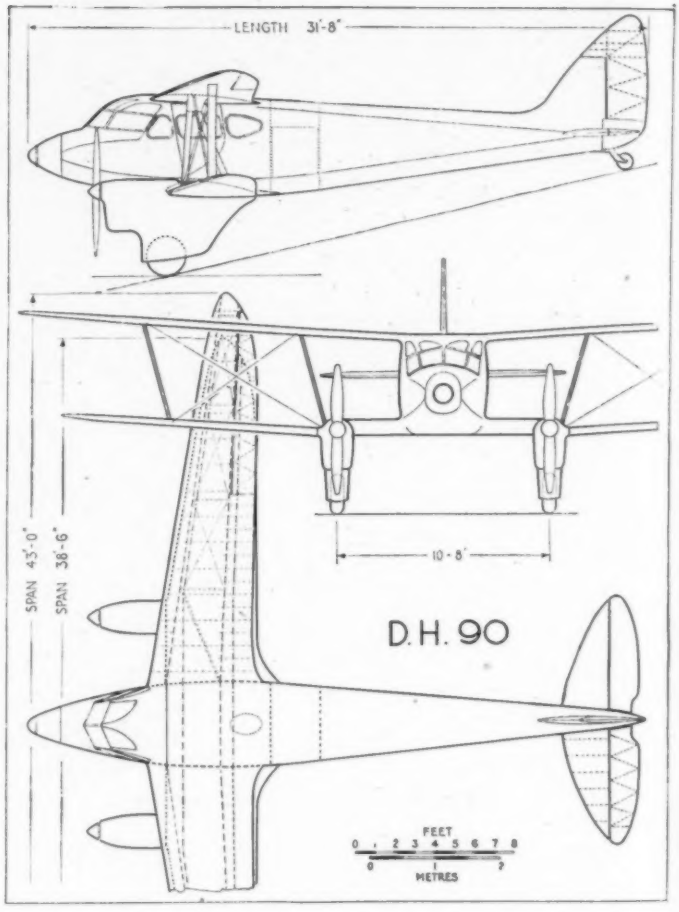
Instead of the usual wire bracing in the inner bay, the wing section of the lower wing roots has been thickened to accommodate very stout spars, which are sufficiently strong to take the loads as pure cantilevers. Several advantages arise out of this arrangement. The thick wing section of these roots makes it possible to house a petrol tank of 30 gallons capacity in each, the tanks being, of course, shaped to the wing contour. The spar ends form convenient attachments for the engine mountings and undercarriage legs, as well as for the inverted vee struts of the wing bracing. And finally, the absence of wires makes access to the cabin door easy, a step being provided on the trailing edge, and the top of the wing root forming a convenient platform.

By supporting the landing wheels on each side, a pure cantilever undercarriage becomes possible. Each of the Turner compression struts is anchored at its top to the front spar of the wing root, light metal pads being interposed to prevent crushing of the wood of the spar. The engine bearer is a welded steel tube structure forming a cantilever beam for the engine, and having a rearward pyramid-shaped projection acting as a steadying member to the rear spar. Any tendency of the wing root to twist in a heavy landing is relieved by the inverted vee interplane strut transmitting such torque to the drag bracing of the upper wing.

Less obvious than the changes in wing-structure design are those incorporated in the construction of the fuselage. For a good many years it has been De Havilland practice to build the fuselage as a three-ply flat-sided box, the curve being obtained afterwards by mounting the fabric covering on stringers. In the D.H.90 a totally different system has been adopted. The fuselage is, in fact, a true *monocoque* of wood. This has entailed a certain amount of experimentation in order to find ways and means of forming the three-ply covering to the desired shape. It is, of course, a well-known fact that a flat sheet of metal



The lower wing roots of the D.H.90 are of thick section, and in addition to carrying the wing bracing as cantilever beams they contain the two main petrol tanks, each of 30 gallons capacity, and also carry the engine mountings and undercarriage structure.



or plywood can be bent in one direction but not in two. In other words, it can be bent around a cylinder, but not around a sphere or barrel. In the D.H.90 the sides of the cabin portion of the fuselage, back to the luggage compartment, are bent to a double curvature. They are curved as seen from in front, and they are slightly curved in plan view. By experimenting, the De Havilland engineers found that if dies were used and the plywood pressed before the cement had set, it was possible to persuade the sheet to adapt itself to the double curvature. The process has now been undertaken by Saunders-Roe as a commercial proposition, and the cement used is a synthetic resin applied under heat and pressure. Aft of the luggage compartment the sides are curved in one direction only, i.e., they are straight in plan view. Consequently ordinary flat sheets can be used for the covering.

Although the top and bottom of the fuselage of the D H.90 are flat, the "corners" have a pronounced radius. These are built up of strips of plywood tapered off and fitted together so as to produce the desired curve, and are then glued together in the curved state. Extreme stiffness is obtained in this way, and even a considerable local pressure fails to dent these curved pieces. The only equivalents of normal longerons are light longitudinal members which serve merely to provide a surface on which the fuselage sides and curved corners can be glued.

Regarded from the user's point of view, the De Havilland Dragonfly is a five-seater with roomy cabin accommodation and an exceptionally complete equipment supplied as standard. No attempt has been made to provide a

D H.90 "DRAGONFLY."

Two 130 h.p. Gipsy Major.

Dimensions.

	ft.	in.	*m*
Length o.a.	31	8	*11,78*
Wing span (upper)	43	0	*13,11*
Wing span (lower)	38	6	*11,73*
Height o.a.	9	2	*2,79*
Wheel track	10	8	*3,25*
Engine centres	10	8	*3,25*

Areas.

	sq. ft.	*m²*
Wings	256	*23,77*
Effective body area	32	*2,97*
Total	288	*26,74*
Fin	7.3	*0,68*
Rudder	11.0	*1,02*
Ailerons	17.6	*1,63*
Tail plane	17.1	*1,59*
Elevators	14.5	*1,35*

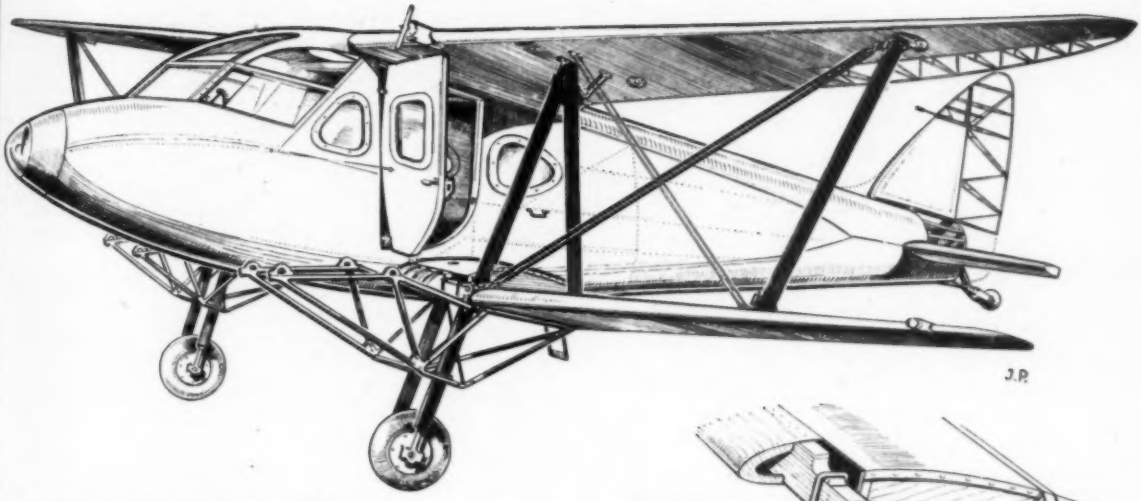
Weights.

	lb.	*kg*
Tare (incl. standard removable equipment)	2,490	*1 131*
Pilot	170	*77*
Passengers (4)	640	*290*
Fuel (normal, 60 gals. = *272 l*)	462	*210*
Oil (7 gals. = *32 l*)	68	*31*
Luggage	170	*77*

With full tanks (85 gals. = *387 l*) the pay load is reduced by 193 lb. (*88 kg*).

Performance.

Max. speed, sea level	144-147 m.p.h. (*232-237 km/h*)
Cruising speed (1,000 ft.) at 2,100 r.p.m.	127-130 m.p.h. (*204-209 km/h*)
Cruising speed (1,000 ft.) at 2,050 r.p.m.	122-125 m.p.h. (*196-201 km/h*)
Cruising consumption (2,050 r.p.m.)	12 gals. (*54,5 l*) per hour.
Ultimate range (60 gals.)	625 miles (*1 005 km*)
Ultimate range (85 gals.)	885 miles (*1 423 km*)
Take-off run-in 5 m.p.h. (*8 km/h*) wind	295 yds. ± 30 yds. (*270 m ± 28 m*)
Height at 656 yds. (*600 m*) from rest	110 ft. ± 15 ft. (*33,5 m ± 4,5 m*)
Distance to stand-still from 50 ft. (*15,3 m*)	340 yds. ± 30 yds. (*311 m ± 27,5 m*)
Gliding angle, flaps up	1 in 10.5
Gliding angle, flaps down	1 in 8
Initial rate of climb	875 ft./min. (*4,47 m/sec*)
Time to 5,000 ft. (*1 525 m*)	6.8 min.
Time to 10,000 ft. (*3 050 m*)	16.8 min.
Absolute ceiling	18,100 ft. (*5 510 m*)
Service ceiling	16,000 ft. (*4 880 m*)
Ceiling on one engine :—	
At 3,750 lb. (*1 700 kg*)	3,800 ft. (*1 160 m*)
At 3,500 lb. (*1 587 kg*)	5,400 ft. (*1 650 m*)
At 3,250 lb. (*1 473 kg*)	7,400 ft. (*2 260 m*)

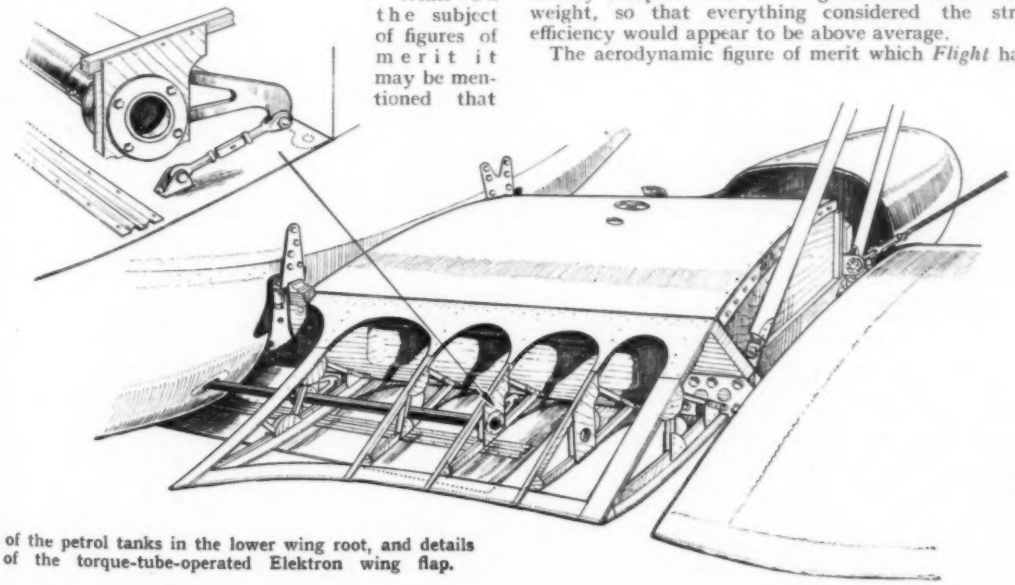


The D.H.90 Dragonfly shown partly "in skeleton." On the right, details of lower wing root, engine mounting and undercarriage attachment.

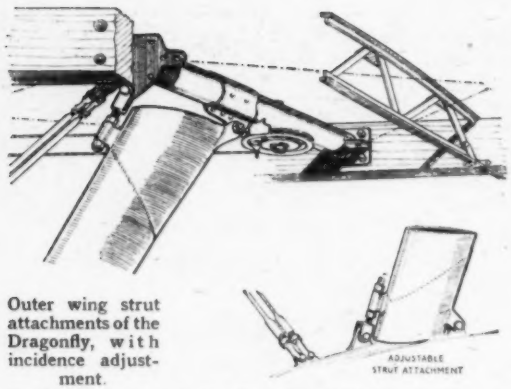
particularly cheap aeroplane, but rather a machine which, in its standard form, is a very comfortable conveyance, equipped to go anywhere at any time, its night-landing and blind-flying equipment being absolutely complete. The cabin layout has accommodation for pilot and four passengers, one of whom sits next to the pilot, one behind him in a separate chair, and two in a sofa seat at the back of the cabin. If one attempts to judge the "commercial efficiency" according to the formula recently suggested by Mr. E. N. B. Bentley (p. 47, *Flight*, January 9), it is important to bear in mind not only that cabin comfort has been aimed at rather than getting the maximum number of passengers into the space available, but also that an unusually complete equipment is carried in the standard machine. This latter has naturally had its effect on the price (£2,650) Even so, however, the commercial efficiency, on Mr. Bentley's formula, works out at 3.77, which must be regarded as very good when everything is taken into consideration.

While on the subject of figures of merit it may be mentioned that the ratio of gross to tare weight of the D.H.90 is 1.61. Superficially this indicates about an average value, but the tare weight includes 133 lb. of removable equipment, such as tool roll and grease gun, log and instruction books, airscrew covers, accumulator, three seats and cushions for sofa seat, fire extinguisher, and carpets. Furthermore, the permanent equipment is unusually complete and adds a good deal extra to the tare weight, so that everything considered the structural efficiency would appear to be above average.

The aerodynamic figure of merit which *Flight* has been



One of the petrol tanks in the lower wing root, and details of the torque-tube-operated Elektron wing flap.



Outer wing strut attachments of the Dragonfly, with incidence adjustment.

in the habit of using is the Everling "High-speed Figure" $\eta/2k_n$; for the Dragonfly this works out at 23.7, which is good for a twin-engined biplane.

Detailed particulars of performance are given in the table on p. 80. The take-off run may appear somewhat long, but it should be realised that the permissible gross weight is rather greater than one would expect from the dimensions of the machine. That is to say, the normal gross weight figure adopted is larger than would have been quoted a few years ago. Machines are now operated in all sorts of geographic and climatic conditions, and the time appears to have come when operators must be allowed to use their discretion in the matter of load carried in their particular circumstances.

Total tankage is provided for a still-air range of 885 miles at a cruising speed of about 125 m.p.h. The two wing-root tanks hold enough for 625 miles. Another 25 gallons can be taken in the tank built into the machine under the sofa seat.

The standard instrument equipment of the D.H. Dragonfly includes a number of Smith's instruments, airspeed indicator, two revolution indicators, two oil-pressure gauges, eight-day watch, Husun Mark IIIA compass, one air log, P.3 type, Sperry artificial horizon and Sperry directional gyro, and three petrol meters. "Demec" navigation lights are fitted, and a Rotax landing searchlight. The electric generator is driven by a windmill, and associated with it is a 25 amp.-hr. battery. The gyro instruments are driven by two venturi tubes mounted in openings in the port lower wing root, where the airflow is of high velocity, thus enabling the blind-flying instruments to be used for the take-off. The Gipsy Major engines drive wooden airscrews with the Schwarz protective finish.

THE AIRPORTS CONFERENCE AND EXHIBITION

Next Week's Arrangements

MORE than sixty organisations which are interested in the ownership and operation of aerodromes have signified their intention of sending delegates to the Aerodrome Owners' Association Conference, which will be held in London—at British Industries House, Marble Arch—from January 30 to February 1. Moreover, the total of firms showing at the Airports Equipment Exhibition, held in conjunction with the Conference, has now reached the notable figure of seventy-five. They are set out below.

Viscount Swinton, Secretary of State for Air, has promised to open the Conference and Exhibition on January 30 at 11.30 a.m. On January 31 three papers will be read and discussed. The subjects chosen are "Aerodrome Wireless," by Mr. R. P. G. Denman, a director of Heston; "The Building of an Aerodrome," by Major R. H. S. Mealing, Chief Technical Assistant to the Department of the Director-General of Civil Aviation, Air Ministry; and "The Acquisition and Planning of a Municipal Airport," by Major Herbert Hamer, City Engineer of Hull.

Cities and towns which have informed the Association that they will be sending delegates number approximately forty, and Eindhoven, Holland, is sending a delegate, while the Belfast Harbour Commissioners will be represented.

Home air transport companies which are already represented on the list of delegates are British Airways, British Continental Airways, Western Airways and Olley Air Services.

On the evening of January 31 the Conference delegates will visit Croydon to study lighting and night-flying arrangements.

The general public are not admitted to the Airports Exhibition, but a complete forecast of the various firms' displays will appear in *Flight* next Thursday, together with special articles on airport construction, maintenance and operation.

EXHIBITORS AND THEIR STAND NUMBERS

Airco (6).
Anglo-American (72).
Architectural Services (54).
Auto Fire Protection (68).
Avery, W. A. T. (31).
Barrus, E. P. (45).
Bell's Asbestos (48).
Benjamin Electric (19).
Boulton & Paul (9).
British Belting & Asbestos (43).
Broom & Wade (52).
Brown Bros. (75).
Callender's Cable (14).
Cardiff Foundry (64).
Cellactite & British Uralite (34).
Cellon (11).
Chance Bros. (46).
Chloride (29).
Churchill, V. L. & Co. (58).
Clarke Chapman (10).
Cook, R. H. (67).
Educational Supply Association (7).
En-Tout-Cas Co. (57).
Fairby Construction Co. (66).
Felco Hoists (73).
"Flight" (21).
Gambrells, Rowse & Snowden (27).
General Fire Appliances (12).
Green, Thomas & Son (42).
Gwynnes Pumps (50).
Hall, John & Sons (26).
Hammond Pump & Equipment (24).
Johnson, C. H. & Son (51).
Kaloroil Burners (23).
Kelvin Bottomley & Baird (30).
King's Cross Truck Co. (70).
Kurt Erlach (69).
Lacy-Hulbert & Co. (60).
Lloyds (Letchworth) (39).
London & Midland Steel Scaffolding Co. (62).
Marconi (44).
Morris & Ingram (2).
National Fire Protection Co. (59).
Negretti & Zambra (20).
Nicholson, W. N. & Sons (17).
Nissen Buildings (5).
Northern Aluminium (41).
Parker, Winder & Achurch (56).
Pillin, John B., Ltd. (71).
Pinchin Johnson (53).
Pitman, Sir Isaac (21a).
Pyrene Co. (32).
Radio Transmission Equipment (25).
Ransomes Sims & Jefferies (18).
Ryland, Llewellyn (4).
Shanks, Alexander & Son (49).
Shell-Mex (8).
Short & Mason (28).
Siebe Gorman (47).
Silvertown Lubricants (33).
Standard Telephones (40).
Streamline Filter Co. (36).
Superflexit (63).
Tecalemit (37).
Temple Press (22).
Thompson Bros. (Bilston) (1).
Titanine Emailli'e (61)
Troughton & Young (58).
Wakefield, C. C. (65).
Water Purifiers (16).
Wayne Tank & Pump Co. (13).
Wilson, T. & Sons (55).
Yorkshire Copper Works (15).
Zwicky (35).

Rudyard Kipling

THERE is no section of the English-speaking world which does not mourn the death of Rudyard Kipling; for there is no section, whatever its tastes, to which there is no appeal in any of Kipling's works. To the flying world he is the author of "With the Night Mail," a short story in the volume *Actions and Reactions*, which was published in 1909. Kipling called his tale "A Story of 2,000 A.D.," and pictured a steel airship carrying the mail from England to America in one night. Of course, the ship was full of marvellous inventions, which have not yet been invented, but, such necessary details apart, Kipling's prophetic story was wonderfully near to the truth. Only in his time factor was he rather badly astray. He was not bold enough to guess at what Dr. Eckener would be doing in 1935, or what Imperial Airways and Pan American Airways are confident of accomplishing in 1936 and 1937. Fact has proved once more stranger than fiction. None the less, all readers of *Flight* will honour the memory of Kipling as the great prophet of air transport, and as the inventor of the motto adopted by his "Aerial Board of Control," "Transportation is Civilisation."

Private Flying

Topics of the Day

The Slow Advance

IMPORTANT though the questions of first cost and maintenance may be, there appears to me to be one and final reason for the virtually imperceptible way in which the number of private owners is increasing. Of course, the fact that it is a steady increase and not a fluctuating figure gives one cause for a little mild optimism, but the increase is hardly what was expected by the majority of interested persons in, say, 1925, when the first real opportunities were provided by a benevolent Government and by one or two far-sighted manufacturers.

This one reason is undoubtedly Weather. The man or woman who feels that ownership is just within his or her means realises that there are a very large number of days in the year on which useful flying is rendered impossible without expensive and difficult aids to navigation. Many keen prospective owners would willingly give up their motoring to pay for flying if they could only feel that they might use their machines on ninety per cent. of the days of the year without running unreasonable risks.

There are, of course, hundreds of well-to-do people who could actually afford to run large machines with fully qualified pilots and/or radio operators, but these people appear to be either too old—in mind or body—or too desperately conservative to consider the idea. A few, for one reason or another, actively dislike or fear the air, and for these one can only feel sympathy. Most of us, at one time or another, were, as children, filled with a quite unreasoning and appalling dread of water, whether deep or shallow.

Depressing the Owner

A WEEK or two ago Miss De Bunsen, the Heston Press secretary, published in her weekly Bulletin some singularly interesting, if depressing, figures concerning last year's weather.

During December, for instance, which was probably, it must be admitted, the worst flying month experienced during the last three years, only *nine* days were fit for the Airwork school pupils and for the average private owner. That, of course, is a staggering admission, but facts must be faced.

Only 217 days out of the 365 of the whole year—about fifty-nine per cent.—were suitable for normal owner pilots, as compared with the 239 days recorded in 1934 and the 281 in 1933. It looks as if things are getting worse, and that eventually every machine, except those which are Lorenz-equipped, will be weather-bound!

Needless to say, the air line and charter pilots merely laughed at the weather on most of the twenty-two wicked December days, but private owners cannot be expected to wait until they have piled up 5,000 hours, or to take a course in R/T and W/T and in semi-blind approaches. Flying is not their lifework.

Safe Guidance

SOONER or later our light aeroplane manufacturers may find it necessary to subsidise some person or persons unknown to evolve means whereby the private owner can fly *and* arrive on the hundred-odd bad days of the average year—means, too, which will not interfere with or endanger the transport machines flying on their more earnest business.

Anybody who has been in Croydon's or Heston's control tower while a radio-less private owner has come in under Q.B.I. conditions will understand what I mean by the word "interfere." On one occasion at Croydon, I believe, an Air France and an Imperial machine were kept waiting outside the controlled zone while some ill-advised owner blundered around before finally deciding that Heston or Hatfield might be better suited to his purposes. He probably received a sharp little note from the Air Ministry if the control officer managed to see his registration letters.

The owner already has an instrument of extreme usefulness in the radio homing device, or even, if he is prepared to use some navigational ability, in the radio compass. Unfortunately, the number of available broadcasting stations is rather limited in this country, though a pilot who is actually lost can always "home" on some station giving a course which will take him to comparative safety over country which is known to have no heights which might be dangerous with a low ceiling.

Short-wave Possibilities

THE use of short-wave transmitters and receivers—which can be both compact and light in weight—has not yet been fully exploited, and the private owner of the future might be assigned a certain waveband at that end of the scale. With a simply operated set and homing device, the normal private owner might be able to increase considerably the sphere of his machine's usefulness.

Furthermore—and this is an important point which is often overlooked, the fully equipped private pilot would not be held back by a caution, which is commendable enough, while his navigational equipment is so limited. Often, in the course of a year, one decides to travel by rail or road simply because of the possibility that, when flying oneself, an unexpected patch of bad weather might send one back to the home aerodrome. People with jobs of work to do cannot afford to take the risk of being unable to get through to their destinations.

For the moment the firms need not worry too much about the owner market, since orders for training and other Service or semi-Service types are keeping them busy, but the market will need to be expanded sooner or later. That is, if I can be optimistic enough to believe that someone will call a halt, eventually, in the race towards mutual and uncomfortable destruction. INDICATOR.

Private Flying

FROM the CLUBS

Events and Activity at the Clubs and Schools

PORTSMOUTH

CONTINUOUS bad weather has kept last week's flying time down to 9 hr. 10 min. Mr. L. J. Pierce, who soloed after 2 hr. 40 min. of dual instruction, has qualified for his "A" licence. Messrs. Cain and Newman have become members.

YORKSHIRE

During the fortnight ending January 18 the Club machines flew 21 hr., although weather was bad on most days. Mr. A. G. H. Rimmel became a flying member and Mr. P. M. G. Thorpe went solo.

LIVERPOOL

Sixty-two hours and fifteen minutes flying has been logged so far this year by the Liverpool Club. Fortunately last Sunday turned out to be a very fine day, permitting 17 hr. 15 min. flying.

HAMPSHIRE

The grand total of flying hours for 1935 was 2,051. Twenty-five members took their "A" licences, and thirty-five members took the blind-flying course. A blind-flying trophy was presented by Frank Wallis, Esq., and a safe-flying trophy by F/O. A. Nicholson Combe. The Club has again become affiliated to the Royal Navy Flying Club.

BORDER

The weather having improved and the altigraph having been returned, several members are progressing toward their "A" licences. Messrs. Hobbis and Robertson completed their tests last week and Mr. Prescott passed the altitude test. Machines travelling to and from Ireland continue to use Carlisle.

LANCASHIRE

Erratic weather conditions, with frequent bouts of fog and wind, have been prevalent at Woodford. Occasional fine periods, however, have permitted members to fly 19 hr. 20 min. Mr. J. Taylor received his "A" licence, and Messrs. Wardle and Cocks became members. Mr. Fell braved the gloom to Speke and back, seeing little but his instruments the whole way.

HERTS AND ESSEX

Flying was suspended for four days of the fortnight ending January 15, but, nevertheless, 69 hr. 58 min. flying was put in. New members are Messrs. J. W. Groome, A. J. Veale, G. H. Goodman, and G. G. Duval. Mr. Duval, who took his licence four years ago but who had not flown since, went solo again after twenty minutes' dual. Mr. J. Dutoict from Belgium went solo after 4 hr. 20 min. dual. The first Club dance of the season will be held on Thursday, February 6. Fancy dress will be worn.

NORFOLK AND NORWICH

The previous week's increase in flying was more than maintained last week, mainly due to Mr. A. Kirkby's keenness in keeping in contact with his pupils. One of these, Mr. H. S. Whitworth, passed his licence tests.

Just before Mr. H. F. Low commenced his lantern lecture on "Air Photograph," at the Club last Sunday evening, a presentation was made by the Chairman, Mr. A. A. Rice, to Capt. J. Collier in recognition of his past four and a half years' service to the Club.

READING

Several potential first soloists have been thwarted recently by the weather. The wisdom of instructors in declining to send them off, however, was proved when, last week, a thick fog completely enveloped the aerodrome in a few seconds. Wing Comdr. Stent, now of the sales staff, started to taxi out for a take-off with the visibility really good only to find that by the time he had reached the circle there was such a fog that it was difficult to return to the hangars. Mr. Van Marken has taken delivery of a smart red Falcon Six.

SOUTH COAST

It was revealed at the first general meeting held last Saturday, with Mr. Francis Haddock, Chairman of the Committee, in the chair, that, although the Club started as recently as September 1, the membership is nearly 250, and about the same number of hours of flying have been put in without incident.

The aerodrome appears to have kept clear of the fog which has been in vogue elsewhere. Mrs. Owen, Miss Houston, Miss Harrison and Mr. Thompson, joined last week. The first annual dinner and dance will be held at Warnes Hotel, Worthing, on February 7.

BROOKLANDS

Thirty-five hours of instructional and solo flying were logged at Brooklands last week in the face of snow, frost and generally bad conditions. Mr. Tom Walls, Junior, has joined the Club, Messrs. Rumsey and Baillie are taking instructor's courses in instrument flying under Capt. Max Findlay, and the Club's technical instructor, Mr. Ashton, has recommenced his lectures.

Another machine has been added to the school's fleet, making a total of ten machines for instructional purposes. The annual general meeting will be held in the clubhouse on Saturday, January 25. At 9.45 p.m. on the same evening sound films will be exhibited.

LONDON

Messrs. H. W. Boutwood and E. A. Goldsmith have gone solo. Last week's flying time was 55 hr. 30 min.

CAMBRIDGE

School and Club machines flew 32 hr. last week. Over the week-end four new members joined the School. Five "A" licences have already been obtained this year.

C.A.S.C.

Last Sunday seven members flew between them 2 hr. 35 min. dual, and 3 hr. 50 min. solo in spite of the fact that the aerodrome was covered with snow. Mr. H. Sale went solo.

BRISTOL

The Bristol and Wessex Aeroplane Club has ordered two B.A.C. Swallows for training purposes. It is hoped that the new machines will arrive before the end of January. Very little club flying was recorded last week because of gales, fog, snow, hail and sleet.

TOLLERTON

Although flying was impossible on most days, last week's flying return shows 16½ hr. Lord Allerton joined as a flying member and took his first lesson on a Moth Major. A dinner and dance held on January 16 was enjoyed by about seventy members.

KARACHI

The Club's four machines flew 229 hr. 20 min. last December. A lecture room has been equipped and opened, and the engineering staff is particularly busy. During the past two or three months five members trained by the Club obtained excellent positions.

HANWORTH

Eleven and a quarter hours flying was done last week. Mr. McLelland went solo, and Mr. Stead became a member. On Friday, January 31 there will be a dinner and dance in the clubhouse, and during the evening the film "Flying the Lindberg Trail," which illustrates the Pan-American air route.

CINQUE PORTS

Mr. Leslie Cliff, the assistant instructor, has left for five weeks' leave. He and his wife have gone first to Berlin to compete in the European skating championship; thence they will go to Garmisch to represent Great Britain at the Olympic games; and finally to Paris to compete in the world's skating championship.

The landing competition held last week resulted in a win for Dr. N. Grellier; his brother, Dr. B. Grellier, was second. A Dragon, a Rapide and a D.H.86, of British Continental Airways, and a Swissair Douglas, used the airport last week. New members of the Club include Capt. E. W. Percival, Mr. C. J. Deedes, and Capt. Roger Peake.

HARROGATE

Although the Harrogate Corporation has yet to make up its mind about an aerodrome site, the recently formed Harrogate Aeroplane Club is determined to obtain a field. This Club is, however, in the fortunate position of being able to operate from two other aerodromes, at York and Leeming.

The local enthusiasm is considerable, and the Club's activities will not affect Yeadon, since the Y.A.C. draws its members mainly from the opposite side of Leeds and Bradford. The Club is linked up with Yorkshire Aviation Services, of Leeming, where there is a swimming pool at Newton House Hotel. The services of Mr. W. Humble, Junr., have been secured as honorary instructor.

EASTBOURNE

The aerodrome at Wilmington has been taken over from the Sussex Aero Club by a new company known as the Eastbourne Flying Club. Considerable improvements have been introduced, including extensions to and renovations of the clubhouse.

At present the Club owns two Gipsy Moths, and the addition of a cabin machine for taxi work is being considered. A dinner and dance will be held at the Grand Hotel on February 21.

Wilmington aerodrome is situated on the main Eastbourne-Lewes road some 6½ miles out of the town, and is leased by the co-operation of Lt. Col. R. V. Gwynne, the owner. The annual subscription to the Club is £2 with no entrance fee, and the flying rates are £2 and 35s. an hour respectively for instructional and solo flying. The secretary is Capt. E. I. Short, the Aerodrome, Wilmington, Sussex.

The Romford Aerodrome

ALTHOUGH the Air Ministry licence for Romford aerodrome has temporarily expired, we learn from the Drone Flying Club that an extension is to be applied for, and that this Club will be in action there for twelve months at least.

January 23, 1936 Supplement to FLIGHT 84a

The AIRCRAFT ENGINEER

"FLIGHT" ENGINEERING SECTION

No. 120 (Volume XII No. 1) 11th Year January 23, 1936

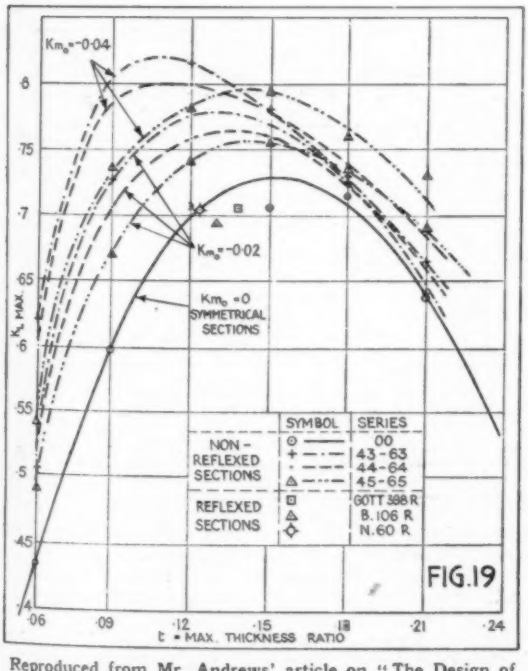
STALLING of TAPERED WINGS

A Reply to Dr. Lachmann's Recent Article in "Flight"

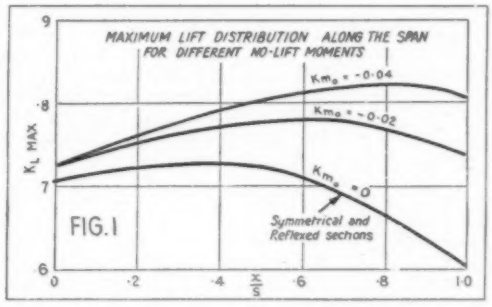
By W. R. ANDREWS, A.F.R.Ae.S.

IN an article which appeared in *Flight* of January 2 under the above title, Dr. G. V. Lachmann gave theoretical reasons to show why a tapered wing stalls first at the tip instead of at the root as in the case of a parallel wing.

Except that the wings he considers are tapered in plan form and are without aerodynamic twist, no limitation is given as to the aerofoil section along the span. From a study of his conclusions, it is obvious that he has considered only wings having the same aerofoil section along the span, that is to say, the relationship between thickness and chord is the same at any section. This undefined limitation is the reason for the conclusions at which he has arrived, as will be demonstrated later. This limitation is hardly in accord with almost universal practice so far as cantilever wings are concerned. It may be true for certain biplane arrangements or nearly so for wings with



Reproduced from Mr. Andrews' article on "The Design of Aerofoils and the Prediction of Characteristics," *The Aircraft Engineer*, December 28, 1933.



elliptical plan forms, where the thickness ratio is more or less constant along the span.

In practice, the more general method of designing wings is to adopt a straight taper, at any rate for the outer portions, and to employ a thickness—chord ratio of about 18 to 20 per cent. at the root, tapering to 9 or 10 per cent. at the tip. The amount of taper in plan (expressed as tip chord ÷ root chord) seems to be from $\lambda = 0.45$ to $\lambda = 0.6$ and for the purposes of illustration tapers of 0.75 and 0.5 have been assumed combined with $t = .18$ at the root tapering linearly to .09 at the tip. These arbitrary cases have been chosen because the loading curves are given in A.P.970 and by coincidence the case of $\lambda = 0.5$ roughly represents current practice for cantilever monoplanes.

It has been demonstrated in a previous article ("The Design of Aerofoils and the Prediction of Characteristics" —*The Aircraft Engineer*, November 30 and December 28, 1933) that the maximum lift of a wing varies with (*a*) **The**

thickness-chord ratio, (*b*) the no-lift moment and (*c*) the point along the chord at which the camber is a maximum (Fig. 19 of the above article is reproduced on the previous page). The tests, upon which this curve is based, were carried out at high Reynolds number in the V.D. tunnel of the N.A.C.A. As a consequence they are likely to be much more accurate than the tests carried out by Mr. P. Nazir (*The Aircraft Engineer*, November 28, 1935) to which Dr. Lachmann makes reference. It is well known that the scale effect upon maximum lift is notoriously high.

Cross-plotting the maximum lift against position along the span, for the thickness taper ratio adopted for illustration, gives the three curves of Fig. 1. From a study of this curve, it becomes at once apparent that the final

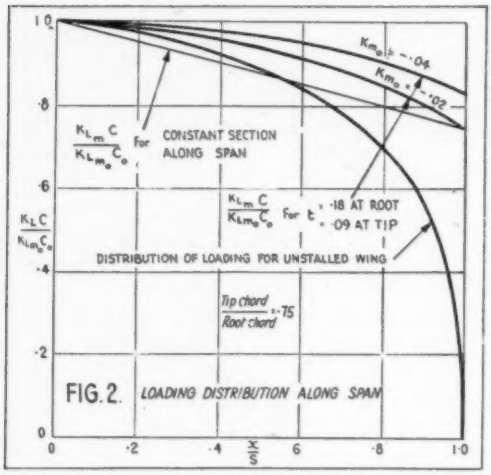

$K_{m_0} = -.04$
$K_{m_0} = -.02$
$\frac{K_{Lm}C}{K_{Lm_0}C_0}$ for CONSTANT SECTION ALONG SPAN
$\frac{K_{Lm}C}{K_{Lm_0}C_0}$ for t = ·18 AT ROOT = ·09 AT TIP
DISTRIBUTION OF LOADING FOR UNSTALLED WING
Tip chord / Root chord = ·75
$\frac{K_LC}{K_{Lm_0}C_0}$
$\frac{x}{s}$

FIG. 2. LOADING DISTRIBUTION ALONG SPAN

characteristics of the wing depend greatly upon the no-lift moment. Such a wing employing a symmetrical or reflexed section would be in a worse position than one employing a constant section of 15 per cent. thickness, assuming that from structural considerations the wing could be made.

The sections employed for a cantilever monoplane have usually a Km_0 between $-.015$ and $-.045$, so that for the purpose of illustration the tapers and thickness ratios already adopted will be combined with $Km_0 = -.04$ and $-.02$ for which K_{Lmax} curves are available.

Damping in Roll

All comparison between wings must be made with reference to some particular standard. This has been arbitrarily chosen as a plain rectangular wing of constant section. Dr. Lachmann has impressed upon us the necessity of obtaining damping in roll, but unfortunately he has not shown how any such comparison can be made. His only remark is that "In spite of this resulting high K_L there is still a margin at the tips for damping in roll due to the falling off at the K_l curve towards the tips," thus implying that damping in roll is a function of the excess lift coefficient only, regardless of the wing area associated with it. For instance, in a triangular wing one *might* have a large excess of lift coefficient under certain conditions, but one ventures to suggest that the damping in roll would be negligible since the area at the tip is zero, and therefore the roll produced by tip due to a change of incidence would also be zero. Obviously the only criterion upon which comparisons of damping in roll can be made is that of wing loading in K_LC.

For each combination of thickness taper and Km_0 there is some plan taper ratio which will give similar damping in roll as the straight wing.

Figs. 2 and 3 have been produced giving K_LC along the span for $\lambda = .75$ and .5. From these it is deduced that the distribution of K_L along the span for the tapered thickness upsets the theoretical distribution of stall along the wing for one of constant section. For the constant section wing, and $\lambda = 0.75$, the whole of the wing inboard of $\frac{x}{s} = .57$ is stalled when the centre stalls, but with tapering thickness—chord ratio stalling definitely takes place at the root first, the remainder of the wing being unstalled.

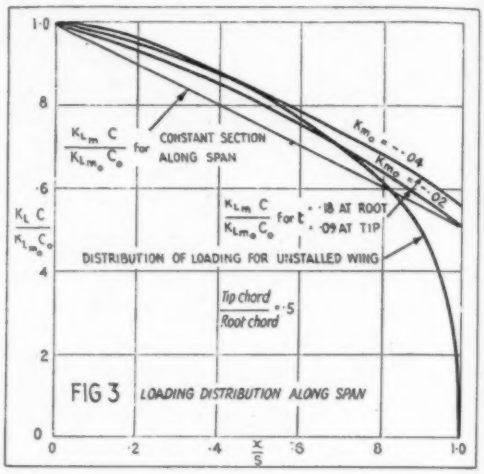

$K_{m_0} = -.04$
$K_{m_0} = -.02$
$\frac{K_{Lm}C}{K_{Lm_0}C_0}$ for CONSTANT SECTION ALONG SPAN
$\frac{K_{Lm}C}{K_{Lm_0}C_0}$ for t = ·18 AT ROOT = ·09 AT TIP
DISTRIBUTION OF LOADING FOR UNSTALLED WING
Tip chord / Root chord = ·5
$\frac{K_LC}{K_{Lm_0}C_0}$
$\frac{x}{s}$

FIG 3 LOADING DISTRIBUTION ALONG SPAN

Where the tip chord is 50 per cent. of the root chord, Fig. 3, the stalling is again greatly modified and for a $Km_0 = -.04$ there are definite indications that the wing first stalls at .2 of the span from the root, as compared with .5 span for the constant section wing. This emphasises the necessity of increasing Km_0 as the taper of the wing is increased. The same effect can be accomplished without increasing Km_0 by moving forward, along the chord, the point at which the camber is a maximum. This has the

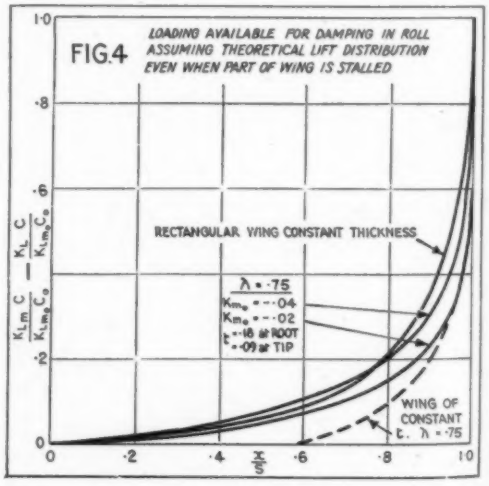
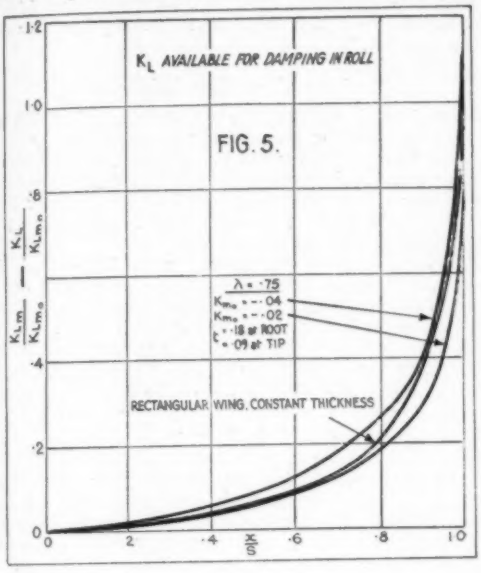

LOADING AVAILABLE FOR DAMPING IN ROLL ASSUMING THEORETICAL LIFT DISTRIBUTION EVEN WHEN PART OF WING IS STALLED
RECTANGULAR WING CONSTANT THICKNESS
λ = ·75
$K_{m_0} = -.04$
$K_{m_0} = -.02$
t = ·18 at ROOT = ·09 at TIP
WING OF CONSTANT t. λ = ·75
$\frac{K_LC}{K_{Lm_0}C_0}$
$\frac{K_{Lm}C}{K_{Lm_0}C_0}$
$\frac{x}{s}$

FIG.4

effect of decreasing slightly the max. K_L at the root but appreciably increasing it at the tip, thus for the same taper ensuring better stalling qualities and improved damping in roll, or for the same damping in roll a higher taper which gives a more advantageous wing weight.

Reverting to the question of the amount of taper for a wing to have equal damping in roll to that given by a "straight" wing, Fig. 4 has been prepared showing the excess of $K_{Lm}C$ over K_LC for both the tapered wing

where $\lambda = .75$ and for the straight wing. It will be seen that the tapered wing $Km_0 = -.04$ is nearly as good as the straight wing. Fig. 5 shows the excess of K_L only, which suggests that of the tapered wings the higher camber is superior to the "straight" wing. It follows therefore that a comparison on a K_L basis is misleading, especially because the effect is accentuated as the taper increases.



All the above remarks and conclusions have been made under the assumption that no body is present at the centre of the wing and that no engines are fitted to the wing. Even with the best of wing root fairings it is inconceivable that the full K_L max. can be attained at the centre, in which case conditions are improved for the tapered wing, and the tendency for the wing to stall first at the root is increased.

The question of wings fitted with flaps has not been considered as the foregoing remarks apply to a lesser degree. From an examination of Fig. 3 of Dr. Lachmann's article there is nothing to suggest the need for a wing tip slot. The K_L near the tip is only about 0.4 and it has been demonstrated that a value of 0.8 may be expected without an excessive Km_0. Even at the edge of the flap a K_L of only 0.7 is shown. The mean K_L of 0.65 for the whole wing is perhaps smaller than would be expected with a slotted flap. In one known case of a monoplane, without flaps, the measured overall maximum lift coefficient is 0.83 based on a wing area including the portion covered by the body, and slightly in excess of 1.0 based on the area outside the body. These lift coefficients were obtained by measuring the stalling speed with the aid of a trailing static head.

In conclusion, it is emphasised that the pessimistic picture drawn by Dr. Lachmann applies only to the case of a tapered wing having a constant thickness ratio along the span, or to a wing having a reflexed trailing edge where Km_0 is almost zero. For a more usual wing arrangement where the tip chord is about half the root chord it is not anticipated that initial stalling will take place at or near the tips but near the root as in a "straight" wing.

TWO-SPAR CANTILEVER WINGS

Part II.—A Method of Determining the Stresses in Spars and Skin

By B. B. WALKER, B.Sc.

(Continued from "The Aircraft Engineer" of December 26, 1935)

THIS method employs the relationship between the slope of the spars and the torque in the skin for the evaluation of the whole of the stresses in the skin and spars, giving incidentally the relative slope of the spars. The latter permits of an easy extension, giving the twist at the tip.

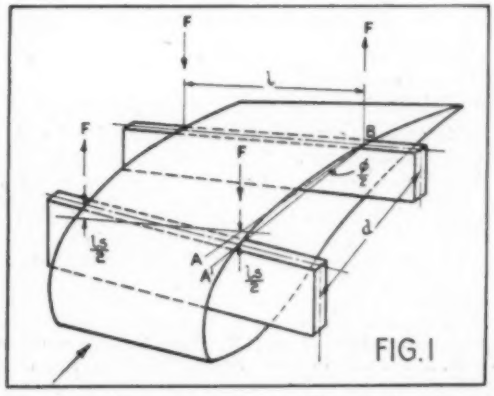
Using the same principles, algebraical methods of finding the stresses in the skin and spars may also be employed, using as basis the division of the length of wing into elements. These will give generally more accuracy than the graphical procedure, the exactness increasing with the number of elements.

In this system of stressing all concentrated torques such as those of outboard engines can be taken into account as well as variation in the thickness or elasticity of the skin, holes or cut away parts of this, or its local replacement by drag bracing.

Principles Involved

At any point in a wing in which the skin or covering is assisting in the resistance to torsion, the torque resisted by the tube formed by the spars and skin must necessarily be proportional to the torsional deflection as measured by the angle of twist per unit length of span. This may vary throughout the span, but at any given point is proportional to the relative slope of the neutral axes of the spars, assuming these to be parallel before load is applied, or to the increase of that slope if they are not.

This relationship may be analysed by considering a portion of skin attached to a length of spars, these being straight throughout the element, but having a relative slope due to load, as shown in Fig. 1. Assume spar and



wing section uniform throughout. The relative slope, s, is that apparent by viewing the spars in the direction of the arrow, normal to the plane of their deflections at the mid-point of the element. Then the relative deflection of

the spars at each end of the element is $ls/2$, where l is the length of the element, these deflections being of opposite sign as shown in the figure.

The angle through which the element has twisted is twice the angle made by the line, A′B, joining given points on the spars after deflection with the line, AB, joining these points before deflection. If d is the distance between spars, and ϕ is the angle of torsional deflection

$$\tan \phi/2 = ls/2d,$$

or for small angles,

$$\phi = ls/d \qquad .. \qquad .. \qquad (1)$$

By Bredt's or Batho's expression we can obtain a torsional stiffness constant K, such that if T is the torque applied,

$$\phi = Tl/K \qquad .. \qquad .. \qquad (2)$$

From (1) and (2)

$$\frac{ls}{c} = \frac{Tl}{K} \qquad .. \qquad .. \qquad .. \qquad (3)$$

Such a torque on a section can be considered as given by four forces of equal magnitude F, being one at each of the ends of the spars at the end of the section.

Then the torque T is represented by the couple Fd, this representation being quite adequate for small values of L.

We have, therefore,

$$F = T/d \qquad .. \qquad .. \qquad (4)$$

The forces F, and therefore the couples Fd, are equivalent to two opposing couples, Fl, having an axis perpendicular to the mean plane of the spars (the arrow in the figure representing this direction).

If this couple is designated by C, then from (3) and (4) :—

$$C = Fl$$

$$= \frac{Tl}{d}$$

$$= \frac{lsK}{d^2} \qquad .. \qquad .. \qquad .. \qquad (5)$$

The spars, therefore, are subjected to a mutual reaction of the nature of a couple of this amount by reason of being connected by the element of skin considered.

Suppose this element is the only portion of skin present in wing, and assume that the "independent bending moment" diagrams (diagram for no skin as defined in Part I) given by the loads on the wing are shown by the curve AVWZ and BXYZ in Fig. 2, the former representing the front spar and the latter the rear spar bending moment, the ordinates being plotted with opposite signs, as was shown in Fig. 1 of Part I of this report.

The presence of the portion of skin will cause the spars to have different curvatures and bending moments for all points inboard of VY, compared to their values for the independent spars, but outboard of this section the conditions are still those of the simple cantilever, and therefore the bending moments and the curvatures must be the same.

Transference of Bending Moment

The foregoing argument shows that the front and rear bending moments must change at the element by an amount equal to the couple C, the changes being of opposite sign.

A bending moment of amount C will, in fact, be transferred from the front to the rear spar, or in the reverse direction. The effect on the bending moment diagram (since there are no other effects of the skin besides the presence of the couples) must be to cause a decrease of one bending moment diagram and equal increase of the other at the points W and X, these being the value C. This is necessary to give equilibrium, as the couples balancing those given by the skin can only be given by the bending moments at the inboard end of the elementary section.

Since the forces F are *equivalent* only to the reaction of the skin upon the spars, and since these reactions in reality take the form of evenly distributed shear loads from the skin acting along the tops and bottoms of the spars and others given to the skin by the spars *via* the ribs, there will be a uniformly increasing divergence between the true bending moment curves and the independent curves throughout the length of the element.

The true curves will, therefore, have the form A′W′VZ and B′X′YZ, in which WW′ and XX′ represent to scale the couple "C."

The Complete Wing

If now there is a skin along the whole length of the wing the resulting bending moment curves will depart gradually from the independent spars in their course from the tip to the root, the increase over the independent value at any point on one spar being equal to the decrease below the independent value of the bending moment at the corresponding point of the other spar.

This is shown in Fig. 3, in which the dotted lines represent the actual bending moment curves, and the full lines the independent. At any point along the horizontal axis the height GG′ is equal to the height HH′.

We have then, if M_F and M_R are the true bending moments of the front and rear spars respectively at any given point and M_{IF} and M_{IR} are their independent bending moments :—

$$M_{IF} - M_F = M_R - M_{IR}.$$

This difference between independent and actual values of bending moment (the same for each spar, but differing in sign) will be referred to as the "transferred bending moment," since at any section of the wing this quantity is equal to the bending moment transferred from one spar to the other by all elements of skin outboard of that point. If it is plotted on the same axis as the other curves, and to the side of it on which the actual bending moment is less than the independent, the ordinates between this curve and the independent curve will give the actual bending moment.

Thus in Fig. 3, in which JH′ is less than JH, the point J′ is plotted with JJ′ equal to this transferred bending moment, this being also represented by GG′ or HH′.

The ordinates GJ′ and J′H obviously represent the actual bending moments.

The method here explained depends upon the relation between the curve of transferred bending moment and the curve of unbalanced moment (as defined in Part I of this article) as determined by the equation above.

The Unbalanced B.M.

The value of the unbalanced bending moment at any point (*see* Part I) is $M_U = \dfrac{M \cdot I_r}{I_r + I_a}$

where $M = M_{IF} + M_{IR}$

If this unbalanced bending moment is plotted on the combined graphs of M_{IF} and M_{IR} as explained in Part I, it will fall generally throughout all or most of its length on the same side of the horizontal axis as the transferred bending moment curve, and will have greater ordinates.

The curves will lie as in Fig. 4, that is to say, if, as has been assumed for Figs. 2 and 3, M_R is less than M_{IR}, bringing the transferred bending moment curve above the axis, this condition will have arisen by reason of the unbalanced bending moment curve being above the axis, and the transferred bending moment curve will be below the unbalanced bending moment curve as shown. This is because if M_{IF} is greater than $\dfrac{M \cdot I_F}{I_F + I_R}$ as assumed, the deflections of the front spar must be greater than those given for the bending moments $\dfrac{M \cdot I_F}{I_F + I_R}$ which are the same as those given by the rear spar for $\dfrac{M \cdot I_R}{I_F + I_R}$ and

the deflections of the rear spar must be less than these by a similar reasoning. The relative slope is then such as to transfer a bending moment from front to rear spar throughout the wing.

This is shown in Fig. 5, where the central line OB is supposed to be the deflection graph of the wing if the balanced bending moments only are applied to the spars (i.e. $M\frac{I_f}{I_f + I_r}$ to the front and $M\frac{I_R}{I_f + I_r}$ to the rear) the deflections then being equal.

In the actual case the front spar is loaded to a greater extent and (for ordinary up load with the C.P. between the spars) will take a position shown by the upper dotted line OF.

The rear spar, being loaded to a lesser extent than the balanced bending moment curve represents, will take up a position below the line OB, which may be denoted by OR.

It is clear then, that the deflections shown between OF and OB will be those due to the excess of the actual front spar bending moments over the balanced, and similarly the deflections between OB and OR are due to the difference between the balanced and the actual in a reverse direction. These moments can be seen by Fig. 4 to be indicated by the ordinates J'K, or the difference between the unbalanced and transferred bending moments.

the independent bending moments according to the way in which the wing is twisted.

The only curve that need actually be plotted as a preliminary is that of unbalanced bending moment, values for this being found from a mere tabulation of M, M_f, and M_R, (or alternatively M, M_f, and M_{fR}).

Graphical Method

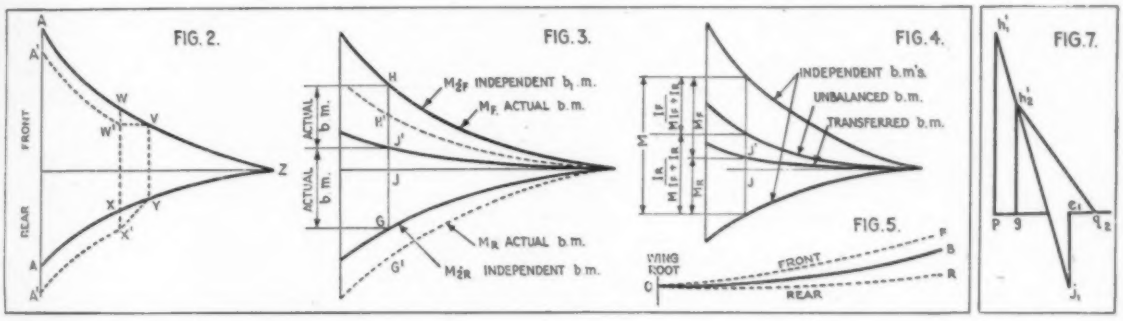
Construct the curve $b\,b'_1\,b'_2$ B (Fig. 6) of unbalanced bending moment to as large a bending moment scale as possible, but leaving room to the right or left of the figure for other graphical work, as shown in Fig. 6. Divide the length of the wing, represented by OB into a convenient number of elements (five are shown for clearness, but seven to ten are better in most cases).

Let 1, 2, 3 . . . B denote the outboard ends of these elements, and 1′, 2′, etc., their centres. Let the length of an element be l.

Find values of $\frac{E}{l}\cdot\frac{I_f}{I_f + I_r}\cdot\frac{I_r}{I_f + I_r}$ for points 1′, 2′, 3′, etc.,

and values of $\frac{lK}{d^2}$ for points 1, 2, 3, etc.

E is Young's modulus for spruce (or the spar material used).



This bending moment, being the same for both spars, and determining their relative deflection, will be termed the "differential" bending moment, and be denoted by M_d.

The transferred and differential bending moments together constitute the unbalanced bending moment. The latter can be found easily, as described in Part I. Its division into transferred and differential bending moments can be effected by simple methods if the wing is divided into a number of elements. In any one element moments of inertia of the spars, and torsional stiffness of the skin are considered constant, but the order of accuracy is high if sufficient elements are used (eight for an ordinary wing with straight or smooth taper are sufficient).

A graphical method is described here. An algebraic method is also possible. Both make use of the relation shown by equation (5) and of the fundamental relationship between spar bending moments, slope and curvature, as applied to the differential bending moment and relative deflection of the spars.

It will be seen that the curvature of the front spar at any point, due to differential bending alone, is M_d/EI_f, while that for the rear is M_d/EI_R.

The total change of relative slope of the spars is, therefore, given by adding these, so that if s is this slope

$$\frac{ds}{dx} = \frac{M_d}{E}\cdot\frac{I_f + I_r}{I_f \cdot I_r} \qquad \ldots \qquad (6)$$

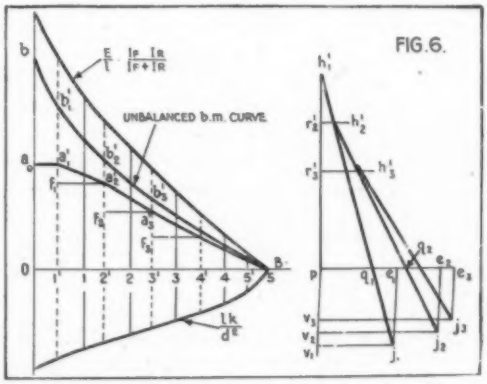
Various sign conventions may be used, but it appears least confusing always to consider the unbalanced, differential and transferred bending moments positive when evaluating the ordinates for these by either of the method that follows, and afterwards to add or subtract these from

I_f and I_R are the moments of inertia of the front and rear spars.

d is distance between spars.

K is Bredt's constant of torsional stiffness of the skin.

It is convenient to plot these on the same axes as the unbalanced bending moment for the convenience of pro-



jection of ordinate, as shown. The scale of one curve should be a simple multiple of the other.

On the vertical axis through O select a trial height O_{a_0} to represent the transferred bending moment at the root. Draw $a_0\,a'_1$ horizontally to meet the vertical through 1′ at a'_1.

If $1' b'_1$ is the ordinate representing unbalanced bending moment at 1', make $p\ q_1$ equal to $a'_1 b'_1$ on another diagram and draw $p\ h'$ at right angles to it to represent $\frac{E}{l} \cdot \frac{I_r \cdot I_s}{I_r + I_s}$ at 1' to the scale chosen. It is naturally convenient for projection to draw $p\ q_1$ horizontally in line with OB, as shown in Fig. 6.

Also, by projection or otherwise mark off $r'_2\ r'_3$, etc., such that $p \cdot r'_2$ represents $\frac{E}{l} \cdot \frac{I_r \quad I_s}{I_r + I_s}$ at 2', $p\ r'_3$ denotes it at 3', etc.: on the opposite side of $p\ q_1$ mark v_1, v_2, v_3, etc., such that $p\ v_1$ represents to the chosen scale the value of $\frac{lK}{d^2}$ at the point 1, while $p\ v_2$, $p\ v_3$, etc., represent it for points 2, 3, etc., respectively.

Join h'_1 to q_1 and produce this line to meet at j_1 the line through v_1 parallel to $p\ q_1$.

Let the projection of $q_1\ j_1$ on to $p\ q_1$ produced be $q_1 e_1$, as shown. This represents to the same scale as $p_1\ q_1$ a bending moment difference; transferring this to the other diagram, with due regard to scales, mark a'_2 on $2'b'_2$ such that $2'a'_2$ is less than $1'a'_1$ by the moment in question.

This may easily be done by making $a'_1 f'_1$ in $a'_1\ 1'$ represent the moment, and drawing $f'_1\ a'_2$ parallel to OB to meet $2'\ b'_2$ in a'_2. Let the moment thus transferred be C_1 units.

Make $q_1\ q_2$ equal to $a'_2\ b'_2$ by producing $p\ q_1$ to q_2. Let the parallel to $p\ q_1$ through r_2 meet $h'_1 q_1$ in h'_2. Join $h'_2 q_2$ and produce it to meet in j_2 the parallel to $p\ q_2$ through v_2.

Let $q_2\ e_2$ be the projection of $q_2\ j_2$ on $p_2\ q_2$.

This represents a moment which $= C_2$, say. Transfer this moment as before, making the difference between the moments shown by $2a'_2$ and $3a'_3$ equal to C_2.

Make $q_2\ q_3$ in $p\ q_2$ produced represent the moment shown by $a'_3\ b'_3$ and proceed as before, joining q_3 to h'_3 the intersection of $h'_2\ q$ and the parallel to $p\ q_3$ through r'_3.

Continue a similar construction progressively to obtain points a'_4, etc., till a point (in this case a_5) is obtained in the vertical for the centre line of the outermost element.

If this point is such that the smooth curve through a'_1, a'_2, etc., passes through B, when extended approximately in a straight line, this curve then is to a very good degree of approximation the curve of transferred bending moment, from which the actual bending moment curves may be obtained as explained in the section on "principles involved."

Trial and Error

If this condition is not satisfied, other series of points, such as a_0, a'_1, a'_2, etc., must be found, starting with different positions of a_0, until one of them gives the required result.

A curve of error may be plotted after two nearly correct series of point have been found.

If further accuracy is needed the construction may be continued to give the last line of the series $a_0 a'_1$, $a_1 a'_2$, etc. (i.e. a line which in the case shown is to the right of a'_5).

This may be done by using the value of $\frac{lK}{d^2}$ at the tip (represented by B) to give a final projection on $p\ q_1\ q_2 \ldots$

Let the value of the couple represented by these be C_5. Then if the ordinate $5a'_5$ denotes a bending moment greater than half C_5, the line to be drawn by the construction would obviously pass above B, while if it is less it will pass below. If the quantities are equal the line will pass through B; and trial lines $a_0 a'_1 \ldots a'_5$ should be drawn until the condition is satisfied.

When a sufficiently accurate line has been drawn for $a_0 a'_1 \ldots$ B, the relationships explained in the section on "principles involved" may be used to give the actual bending moments, and hence the stresses in the spars. It will be seen, by reference to Fig. 4, that in the most usual case (which this figure represents) of the unbalanced bending moment curve having the same sign throughout the span, the addition or subtraction of the transferred bending moment to or from this to give the actual may be memorised by the simple rule that where the independent bending moment is greater than the balanced the transferred bending moment is subtracted from it to give the actual and *vice versa*. When there is reversal of sign of the unbalanced bending moment curve the relationship is easily seen by drawing out a set of curves such as shown in Fig. 4.

The stresses in the skin are given from the torque taken by the skin. This at any point is equal to the slope of the transferred bending moment curves, expressed in units of force (e.g. lb.-ins. per lb., i.e. lbs.), multiplied by the distance between the spars.

If this torque is T units the shear stress in the skin at any point is equal to $\frac{T}{2At}$, where A is the mean area of the tube formed by the skin, and t is its thickness at the point considered.

Proof of Graphical Method

Assume that in Fig. 6 the points $a_0\ a'_1\ a'_2 \ldots$ B are the final series satisfying the conditions of construction. Let Fig. 7 represent the right-hand construction of Fig. 6. Drop a perpendicular from h_2' to pq_1 to meet it at g.

Then since $p\ h_1'$ represents to some scale $\frac{E}{l} \cdot \frac{I_r \quad I_s}{I_r + I}$ for the element O1 (assuming the average value to be sufficiently accurately shown by the value at the centre of the element) and $p\ q_1'$ represents to another scale the average differential bending moment in the element (being equal or proportional to $a_1'\ b_1'$) the tangent of the angle $q_1 h_1' p$ represents to a derivative scale the increase in the relative slope of the spars from the root to the point represented by 1. This follows from the relationship expressed by equation (6).

Since the relative slope at the root must be zero, it follows that this tangent, or the slope of $h_1' q_1$ relative to the vertical, represents to this scale the relative slope at 1, assuming the transferred bending moment to be correctly represented by Oa_0.

If we now assume that $2'a'_2$ correctly represents the transferred bending moment at 2, so that $a'_2\ b'_2$ and $q_1\ q_2$ also represent the differential bending moment at 2 (by construction) we have :—

$$\text{Tangent of angle } q_2 h_2' g = \overline{gq_2}/\overline{gh_2'}$$
$$= \overline{gq_1}/\overline{gh_2'} + \overline{q_1 q_2}/\overline{gh_2'}$$
$$= \overline{pq_1}/\overline{ph_1'} + \overline{q_1 q_2}/\overline{gh_2'}$$
$$= \text{constant for scale} \times M_{d1} \cdot \frac{l}{E} \cdot \frac{I_{r1} + I_{s1}}{I_{r1} \cdot I_{s1}}$$
$$+ M_{d2} \cdot \frac{l}{E} \cdot \frac{I_{r2} + I_{s2}}{I_{r2} \cdot I_{s2}}$$

where M_d denotes differential bending moment and the suffixes 1 and 2 after I denote its average value in the element 0–1 and 1–2 respectively.

This follows from the fact that gh_2' was made equal to

$$\frac{l}{E} \cdot \frac{I_r + I_s}{I_r \times I_s}$$

for the point 2' (which is within sufficient accuracy equal to the average value for the element 1–2) and from the relationship of equation (6).

Thus the slope of $h_2' q_2$ relative to the vertical (or tangent of the angle $q_2 h_2' q$) represents to the same scale as for the slope in the first element the sum of the changes in relative slope of the spars in the elements 0–1 and 1–2; that is, it represents the relative slope of the spars at the point on them represented by "2" on the diagram.

Further, it can be shown in similar fashion that, assuming the bending moments represented $a_1' b_1'$, $a_2' b_2'$, $a_3 b_3'$, etc., correctly to show the differential bending moments, the slope relative to the vertical of any line in the series

$h_1'q_1$, $h_2'q_2$, $h_3'q_3$ . . . will represent to the above mentioned scale the relative slope of the spars at the point in them denoted by the suffix of q.

Thus the slope of $h_3'q_3$ to the vertical represents the relative slope of the spars for the point "3" on the diagram, etc. If we now consider the lower part of the construction on the right of Fig. 6, of which the first item $q_1 j_1 e_1$ is shown in Fig. 7, it will be seen that the slope of $q_1 j_1$, that is of $h_1'q_1$, relative to the vertical, represents to the scale considered the mean relative slope of the spars in the element 1'2' of which the mid-point is at 1 (Fig. 6).

Therefore, if s_1 is this slope, q_1e_1 represents to some scale s_1Kl/d^2 for the point 1 (since e_1j_1, being equal, pv_1 in Fig. 6, represents Kl/d^2 at point 1). This means that $q_1 e_1$ represents by equation (5) the couple that is transferred from one spar to the other in an element of wing of length l, having a mean relative slope s_1 of the spars and a torsional constant equal to that at the point 1. These conditions are, to a sufficient approximation, those of the element 1'2', so that q_1e_1 represents the couple transferred in this element.

By making a_1f_1 in Fig. 6 represent to the correct scale the same moment as $q_1 e_1$ it represents the couple that is transferred in the element 1'2', provided the mean slope is s_1; so the difference of the ordinates $1'a_1'$ and $2'a_2'$ at the extremities of the element 1'2' is that of the correct transferred bending moment curve, provided that the slopes of $h_1'q_1$, $h_2'q_2$, etc., correctly represent to their scale the relative slopes of the spars in the elements 0–1, 1–2, 2–3, etc., respectively.

It has been explained that the changes of slope correctly correspond to the moments given by $a_1'b_1'$, $a_2'b_1'$, etc.

If, therefore, as has been assumed, the line $a_0a_1'a_2'a_3'$ etc., is the final line satisfying the constructional conditions, it shows a zero ordinate for transferred and differential bending moment at the tip, and a series of average relative slopes of the spars; the differences of these slopes correspond in accordance with equation (6) to the differential bending moments indicated by the line ($a'_1b'_1$, $a'_2b'_2$, etc.); also the slope at any point considered corresponds in accordance with equation (5) to the couple shown by the line to be transferred from one spar to the other ($1a'_1$, $2a'_2$, etc.) if the line is read as the curve of transferred bending moment. The line $a_0\ a'_1\ a'_2\ a'_3$ . . . satisfies, therefore, the conditions of the transferred bending moment curve within the limits of accuracy implied by the use of elements. The accuracy can naturally be indefinitely increased by the use of a larger number of smaller elements.

Application to Exceptional Structures

The method can obviously be made to take account of concentrated loads (such as those of engines, tanks, etc.) on the wings by the inclusion of the bending moments due to these in the "independent" bending moment diagrams for any particular case. For this purpose the structures supporting overhung engines may generally be taken as quite rigid (their deflections being small compared with those of the spars due to bending), so that the engine loads give simple upward or downward reactions on the spars relieving or adding to the air loads. The weight of the wings, properly proportioned between the spars at the various points in their length can also be taken account of in obtaining the independent bending moments. These moments in this method form a complete definition of the loads on the wing. The addition of their slopes at any point gives the shear on the wing, and this must change abruptly at any concentrated load.

Where there are important discontinuities of the skin, such as large manholes, or fabric-covered portions, these can be allowed for by a suitable modification of the constant K for the elements containing them. If an appreciable part of the span has no skin or equivalent or has the skin cut through in such a way as to make it useless for torsion, this portion should be considered in the calculation as one or more elements by itself, the constant K being zero. If it is not possible to approximate by making the length of such a portion equal to "l" or a multiple of it, modifications may be introduced into the graphical construction by which another elemental length is used for this.

If different elasticities occur at parts of the skin as compared with the major part, as in, for instance, the use of sheet metal for the top surface as a removable lid over a tank, this can be allowed for by taking account of the thicknesses and elasticities in the torsional constant K.

If at any part of the wing the wing skin is absent but is replaced by a bay with a diagonal strut capable of taking bending stresses, it can be shown that if m is the mean bending moment in the drag strut, and α the angle the strut makes with the spars the moment that is transferred is $2m \cos \alpha$. The change of slope of the drag strut must be $s \cos \alpha$, where s is the difference between the slope of one spar where connected to the outer end of the drag strut, and that of the other spar where connected to the inner end.

If l_b is the length of the bay measured along the spars, the length of the drag strut is $l_b \cos \alpha$ and we have :—

$$s \cos \alpha = \frac{m}{E\,I_d} l_b \cos \alpha$$

where I_d is the moment of inertia of the section of the drag strut (a mean value being taken).

Therefore
$$s = \frac{m\,l_b}{E\,I_d}$$

or
$$m = \frac{s\,E\,I_d}{l_b}$$

whence the couple c transferred is given by :—

$$c = 2m \cos \alpha$$
$$= \frac{2\,s\,E\,I_d}{l_b} \cos \alpha$$

an equation which may be substituted for (5) in the drag strut bay, so that the equivalent torsional constant K is $2EI_d \cos \alpha / l_b$. Factors neglected in this approximation are the change of the relative slope s of the spars throughout the length of the bay (small except near the root) and the deflections of the fore-and-aft drag struts at the ends of the bay, which must, in this construction, take bending stresses. The drag strut is also assumed to have a uniform bending moment throughout its length, which is only strictly true if it consists of two parallel struts, one above the other, unconnected by a web.

TECHNICAL LITERATURE

SUMMARIES OF AERONAUTICAL RESEARCH COMMITTEE REPORTS

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NOTE ON EXPANDING PASSAGES ON AIRCRAFT. By F. B. Bradfield, M.A. Communicated by the Director of Scientific Research, Air Ministry. R. & M. No. 1661. (5 pages and 7 diagrams.) December, 1934. Price 6d. net.

Attention is drawn to the well known fact that the main cause of large interference drags, of the formation of large wakes, and of early stalls at the wing body junction is the occurrence of passages calling for rapid expansion of the air, and that the function of fairings and fillets is to reduce the rapidity of the expansion required. It is therefore impossible to consider as a separate unit a surface forming one side only of such a passage, i.e., fairing must be done in terms of the complete aeroplane. Several typical examples of expanding passages found in current aeroplane design are described and illustrated.

THE AIRCRAFT ENGINEER

FURTHER EXPERIMENTS ON STATISTICAL MEASUREMENTS OF TURBULENCE. By H. C. H. Townend, D.Sc., of the Aerodynamics Department, N.P.L. R. & M. No. 1655. (10 pages and 4 diagrams.) November 24, 1934. Price 9d. net.

In some recent measurements of turbulence use has been made of a method in which cinematograph records of the movements of small masses of heated air have been used to obtain the velocities. Analysis of the films involved the determination of the displacements of large numbers of such masses from their mean position. The possibility of inaccuracy introduced by the personal factor in reading such films has been tested in the present pipe experiments by using a photo-electric cell to detect the position of the masses instead of measuring them from photographs. The analysis was thereby made automatic.

The results show good agreement with those obtained by film analysis, and indicate that the method is reliable for making measurements of this kind.

THE USE OF SPLIT FLAPS AND OTHER DEVICES FOR FACILITATING LANDING. By S. B. Gates, M.A. Communicated by the Director of Scientific Research, Air Ministry. R. & M. No. 1659. (12 pages and 16 diagrams.) April, 1934. Price 1s. 3d. net.

The evidence of recent experimental work from many sources on the characteristics of split flaps and other devices for increasing gliding angle and maximum lift coefficient is collected and summarised. It is related to the practical problem of giving the pilot an easily controlled means of spoiling the cleanness of his aircraft and decreasing its stalling speed, when he comes in to land. The evidence, so far as it goes suggests that the problem is soluble, either with a split flap or with a slotted flap, without disturbing the action of conventional ailerons.

A few rough indications which may be helpful to designers are suggested :—

(1) A trailing edge flap is the most suitable device for reducing the landing space of a clean, heavily loaded design.

(2) A flap chord of something like 20 per cent. of the wing chord will probably be necessary, and some means of balance is probably essential.

(3) If the trailing edge flap covers the tailplane, the trimming difficulties which would otherwise follow from the large change in load distribution on the wing appear to be avoided.

(4) If the flap is carried right across the body o a low wing monoplane, the wing root conditions should be carefully attended to in order to limit the turbulent wake of the flap, and its effect on the tailplane.

SLOTS AND INTERCEPTORS IN SPINS. By S. B. Gates, M.A., H. B. Irving, B.Sc., R. P. Alston, B.A., A. V. Stephens, M.A. Communicated by the Director of Scientific Research, Air Ministry. R. & M. No. 1660. (29 pages and 20 diagrams.) October 20, 1934. Price 2s. 6d. net.

This is a comprehensive report on several lines of research—in flight, on the N.P.L. spinning balance, and in the R.A.E. Free Spinning Tunnel—upon the effect of automatic slots in developing spins. Some information on interceptor slot control is also included.

In spinning attitudes each slot lifts and advances its wing tip, the forces depending mainly on the local incidence and speed at the centre of the slat. The net effect in a spin depends on the balance between these forces, and also on the influence of the added inertia of the slots and indirect effects depending on the weathercock stability and on the inertia distribution without slots. The change produced by adding slots cannot be predicted in a particular case without an intimate knowledge of the spinning characteristics without slots. The pro-spin yawing moment produced by slots does not usually exceed 10.

A rough classification of slot effect is as follows :—

Spin without slots.	Possible effect of slots.	Example.
Good design, spin at $< 45°$.	Spin steeper, or impossible.	
Good design, moderately flat spin.	Spin flatter.	IIIF landplane.
Poor design, moderately flat.	Possible spins :— Steep or flat, stable. Intermediate, unstable.	Bristol Fighter.

This covers most of the designs tested in the Free Spinning Tunnel.

Either slot may tend to close under inertia forces if it is on the wing which is down in the spin. If the outer slot closes the effect should be favourable. If the inner slot closes it will probably do so only when it has ceased to supply an anti-spin moment. Thus, if slots close in a spin the effect should not be unfavourable. A slot has occasionally been observed to close in a spin, without altering the motion.

Bristol Fighter interceptors do not effectively close the outer slot in a spin and when coupled to the ailerons are rendered ineffective by the adverse yawing moment of the ailerons. In general, if interceptors are fitted it is probably better to couple them with the rudder.

THE AIR DENSITY EFFECT IN SPINNING. By S. B. Gates, M.A., and A. V. Stephens, M.A. Communicated by the Director of Scientific Research, Air Ministry. R. & M. No. 1663. (7 pages and 4 diagrams.) October 25, 1934. Price 9d. net.

It is possible in spinning model tests to represent the effect of a change in air density, or height of the manœuvre, by changing the mass of the model, keeping its centre of gravity and radii of gyration the same. This note summarises recent experiments of this kind at equivalent heights ranging from 5,000 feet to 15,000 feet, and contains a theoretical analysis of the effect of this change in air density.

Experimental results so far have always shown that recovery is easier at the lower height, but the analysis shows that a reversed effect is possible. No simple conclusion can be drawn from the analysis, which suggests however as a rough general rule that recovery will be easier at a lower height if the body tail unit is efficient and there is no tendency to spin flat, and vice versa. The difference in applied yawing moment necessary to make recovery impossible has been observed to be of the order of 20 when the equivalent height is changed from 5,000 feet to 15,000 feet. This is quite sufficient to account for an easy recovery near the ground and a more difficult one higher up.

TURBULENCE TESTS OF THE R.A.E. WIND TUNNELS. By R. G. Harris, M.A., D.Sc., F.R.S.E., and A. Graham, M.Sc., D.I.C. Communicated by the Director of Scientific Research, Air Ministry. R. & M. No. 1662. (6 pages and 6 diagrams.) November 20, 1934. Price 6d. net.

The drag of spheres was measured over the following range :—Reynolds number 1×10^5 to 6×10^5. Sphere diameter : 3 in., 6 in., 9 in. Ventilation of five-foot tunnel : open and closed.

The Values of R at which k_D is 0.15 are :—

Sphere Diameter.	Five-foot Tunnel (Open Jet).	No. 1 Seven-foot Tunnel.	No. 2 Seven-foot Tunnel.
9 in.	2.30×10^5	1.84×10^5	1.76×10^5
6 in.	2.36×10^5	1.90×10^5	1.88×10^5
3 in.	2.79×10^5	—	—

These results are slightly dependent on (a) the history of the flow, and (b) ventilation.

NOTE ON BOUNDARY LAYER FLOW. By H. B. Squire, M.A. Communicated by the Director of Scientific Research, Air Ministry. R. & M. No. 1664. (12 pages and 15 diagrams.) February 13, 1935. Price 9d. net.

In the flow of air past a streamline body it is known that the aerodynamic forces are closely connected with the behaviour of the layer of air near the surface. The sudden changes in flow which occur when a wing stalls or a sphere passes through the critical Reynolds Number are closely related to alterations of the flow in this boundary layer.

A simple account of recent developments in boundary layer theory was required which could be related to the practical aerodynamic problems in hand. In this note the flow along a flat plate and the effect of pressure gradient on the transition of the boundary layer from laminar to turbulent and on break-away are reviewed. Finally, modern theories of the effect of turbulence and variation of Reynolds Number on maximum lift are considered.

ROLLING AND YAWING MOMENTS ON HALF WINGS WITH VARIOUS MODIFICATIONS OF WING TIPS. D. H. Williams, B.Sc., of the Aerodynamics Department, N.P.L. R. & M. No. 1665. (6 pages and 15 diagrams.) July 5, 1934. Price 1s. net.

During the past few years, various devices have been tried on wings with a view to delaying the stall or to flattening the top of the lift curve avoiding especially the sudden drop in lift observed at the stalling angle of some aerofoils. The work described below was the outcome of a suggestion that experiments should be made on wings to find the effect of modifications of the tips of the wings on the form of the rolling moment curve. Instead of measuring lift and drag on an aerofoil in the usual manner, a half wing only was mounted in a 4ft. wind tunnel with the root of the half wing at the wall of the tunnel and rolling and yawing moments about wind axes were measured on the half wing.

Curves are given in this report for a slotted biplane for swept-back and swept-forward wings and for wings with swept-back and swept-forward tips. Sweep-forward of the whole wing lessens the drop in the rolling moment curve above the stall and sweep-back increases it. Swept-forward and swept-back tips have similar effects. The best result was obtained for a wing with the outer third swept-forward 30° with a sharp angle in the leading edge. A swept-forward wing with curved leading edge did not give such a good curve as one with the sharp bend.

A DISTRIBUTION METHOD OF STRESS ANALYSIS. By Professor J. F. Baker, M.A., D.Sc., M.I.Struct.E., Assoc. M.Inst.C.E., and A. J. Eckleston, B.E. (N.Z.). R. & M. No. 1667. (82 pages and 42 diagrams. March 30, 1935. Price 3s. 6d. net.

Scant attention has been given in this country to a method of determining the stresses in frameworks, described some years ago by Professor Hardy Cross which should be of considerable use to aeronautical engineers.

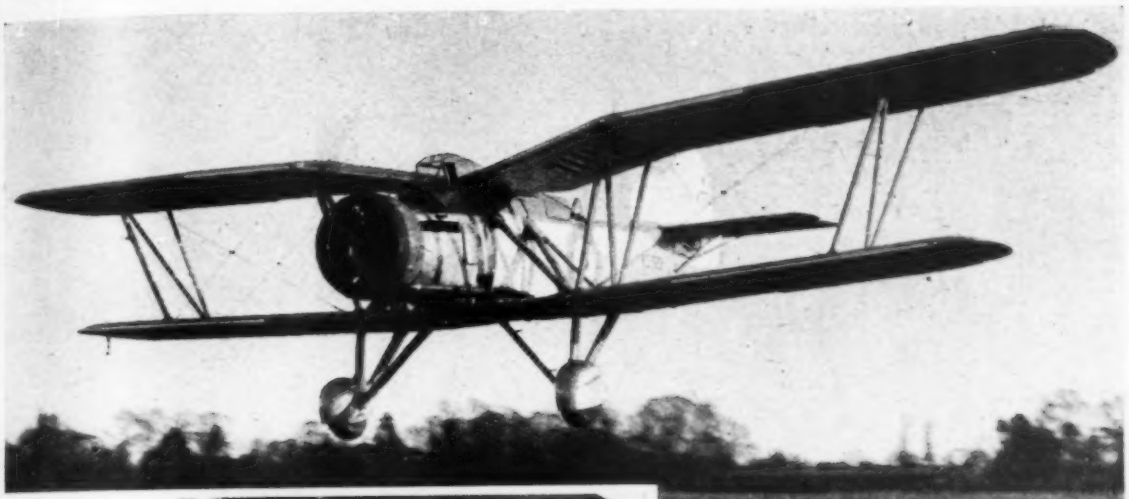
Cross illustrated his method of analysis by determining the bending moments in rectangular building frames with perfectly stiff joints so constrained that no translation of the joints was possible. The better known methods of dealing with this problem, such as slope deflection or minimum strain energy, imagine the structure cut at such sections as would make it simply stiff and necessitate the solution of equations which set out the relations between the angles through which the cut ends must turn, or the reactions necessary to bring about these rotations, to make the structure continuous again. The Cross method, however, not only keeps the joints stiff but, in the first place, fixes them in space so that the structure can be considered as made up of members encastered at their ends. The application of the external load system produces end moments in the members and also an external moment at each joint since it is fixed in space. One joint is then released, that is to say the external moment is removed and the joint is no longer in equilibrium. It immediately rotates until a new equilibrium position is reached, and in so doing modifies the end moments in the adjoining members. This joint is now fixed again in its new position and another joint is released which moves into a new equilibrium position, further modifying the end moments.

This distribution method appears to be complicated but when a number of examples have been worked out and the physical significance of the various steps grasped, the full simplicity of the method will be appreciated. It has one great advantage over the more usual methods in that simultaneous equations, apart from the groups of three used in determining the various factors, are avoided and the behaviour of the frame under any load system can be visualised at every stage. The investigator is thus able, with confidence, to make slight alterations in the normal procedure to suit particular cases. He is able to carry his work to any desired degree of accuracy and is not tempted, as in other methods, to make simplifying approximations the full significance of which cannot be gauged.

While the distribution method can be used on a highly redundant structure without considerable labour it enables a solution to be obtained in many cases where other methods are impossible.

MAID-of-all-WORK

The New Parnall General-purpose Biplane



This series of *Flight* photographs illustrates various aspects of the Parnall G4/31 general purpose biplane. (Top) A general impression; (centre left) Captain H. J. Saint, who has put the machine through its tests at Yate; (centre right) the arrangement of the Pegasus engine, "gull" type upper stub wings and wide undercarriage, and (right) propulsive effort by members of the ground staff. Note in this picture the pilot's enclosed cockpit. A further view will be found on page 88.

THE FOUR WINDS

ITEMS OF INTEREST FROM ALL QUARTERS

NOT A NEW METHOD of airport traffic control, but a very fine piece of mural decoration by Maurice Lambert for the Transport and Airways Office in the *Queen Mary*. Measuring 5 ft. by 9 ft., it is executed in anodysed aluminium.

CONTRACTS totalling several hundreds of thousands of pounds have been placed by the Air Ministry for C.P. airscrews.

Instruction in aeronautics will be given at Rossall School this term.

With flaps the Avro Anson lands at 57 m.p.h.; without them, at 66 m.p.h.

A civil version of the Marcel Bloch 210 bomber is being built for Air France.

A Glasgow enthusiast intends to fly from Clydeside to South Africa during April in a *Pou*. He is fitting extra tanks giving seven hours' endurance.

Maryse Hilsz is to attack the woman's altitude record in a Potez.

At present acting as host to the Viceroy of India, Thakore Sahib, ruler of Limbdi, tours his state in an Autogiro. He is 68 years old.

A balloon with two airmen and an astronomer on board rose to 21,000ft. from Moscow on the night of January 8 to observe the lunar eclipse. The trip was counted successful.

The Royal Aero Club has been informed that the Egyptian meeting, which was to have been held in March, has been postponed indefinitely owing to the present political situation.

A "*Pou*" Rally

August Bank Holiday has been fixed as the date of a great assembly of "*Poux*" at Ramsgate. It will be interesting to see if the attendance, after a spring's and part of a summer's "*Pou*" flying is as great as seems to be expected.

Exit en Masse

M. Henry Farman has decided to provide ten openings in the fuselage of the Farman F.224 forty-seater passenger machine now being built for Air France, to facilitate exit of the passengers by parachute. The 'chutes themselves will be carried in the backs of the seats.

Howard Hughes' Mount

Apparently, the machine used by Mr. Howard Hughes to break the American Transcontinental record, as recorded in *Flight* last week, was Miss Jacqueline Cochran's Northrop Gamma (Twin Wasp Junior).

Catering for Canada

A new company which intends to build aeroplanes specially for the Canadian market has started business in Montreal. Its first product is the Norseman, a high-wing monoplane with a 420 h.p. Whirlwind; it does 158 m.p.h. as a landplane. Mr. R. B. C. Noorduyn, who is not unknown over here, is the designer.

ABYSSINIA FROM ABOVE: This photograph, and the two on the opposite page, were taken recently from Italian aircraft. The extremely ant-like creatures seen here are *Il Duce's* soldiers concentrating before a "push."

OVER ETHIOPIA: Apart from the unpleasant fate which is alleged to await Italian pilots who make forced landings in Abyssinian territory, the terrain suggests that the forced landing itself may be sanguinary enough. The machine—one of the "Disparata" squadron—is a Caproni 101.

For Public Transporters

A Public Transport Pilots' Certificate is now being issued in Canada. It is the highest grade of pilot's certificate available over there, and corresponds approximately to the British "B" licence and the American Transport Pilots' Certificate.

Past and Present

Members of the Royal Aeronautical Society and of the Air League of the British Empire attended a private view last Friday evening of "The Empire's Airway" Exhibition at the Science Museum, South Kensington. Many of the visitors and their friends, after inspecting the Exhibition, concluded the evening in the Museum's ordinary aeronautical section, which contains exhibits of the greatest historical interest.

Airports Conference Luncheon

Viscount Swinton, Secretary of State for Air, will be one of the speakers at a luncheon to be given at Grosvenor House, London, on January 30, by the Aerodrome Owners' Association.

Next R.Ae.S. Lecture

The next R.Ae.S. lecture takes place on Monday, February 3, when Dr. H. C. Watts will deal with "Airscrew Development." The lecture will be held at the Institution of Electrical Engineers, Savoy Place, London, W.C.2, at 6.30 p.m. Visitors will be admitted only by ticket obtainable through a member.

Twenty-five Years Ago

(From "Flight" of January 21, 1911.)

"On Saturday last Mr. G. de Havilland successfully put his biplane through the tests required before the War Office actually acquired his machine. It will be remembered that his first attempt resulted in considerable damage to the machine, which has since been repaired. The machine is slightly smaller than the best-known types, being about 5ft. deep and 30ft. wide."

Fire-Floats

The new French Romano R.90 fleet-fighter seaplane may be armed either with two 20 mm. *canons*, which are mounted in its floats, or with four machine guns, two in the lower wing and the others in the floats.

Hotting-up in Hollywood

Mr. Douglas Shearer, head of the sound department of Metro-Goldwyn-Mayer, has fitted his cleaned-up Avro Avian (1928 vintage) with a 120 h.p. Menasco, and is getting nearly 120 m.p.h.

You Pays . . .

The Fairey Kangourou, or single-seater Fox, illustrated in *Flight* last week, is readily convertible into a two-seater bomber or five-gun fighter. It does 232 m.p.h. and climbs to 16,400 feet in seven minutes.

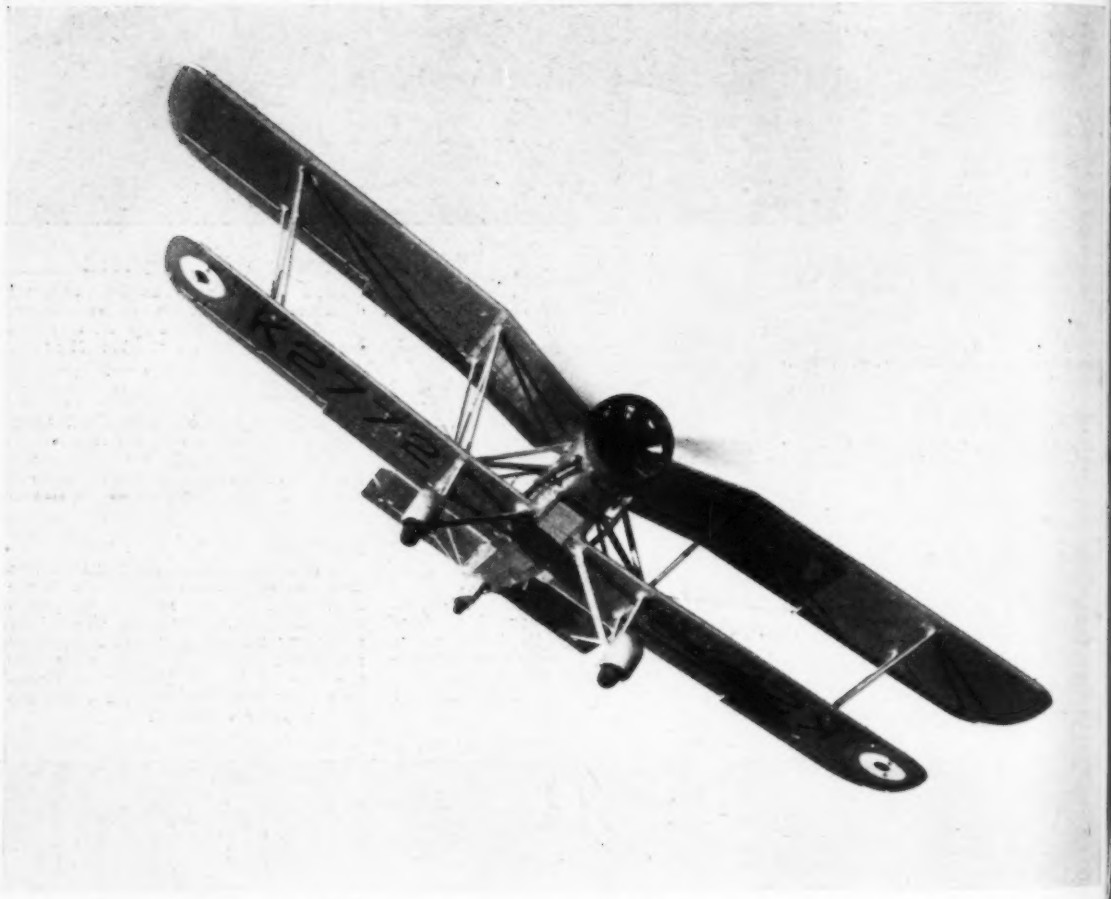
Foresight

A Bill deposited by the Mersey Docks and Harbour Board contains a clause allowing it to levy rates on seaplanes and goods and passengers shipped or unshipped from seaplanes at the port of Liverpool, provided such rates are approved of by the Minister of Transport after consultation with the president of the Air Council.

MUCH ADO ABOUT ADOWA: This, even allowing for the doll's-house effect of all aerial views, is all there is of the much-headlined objective.

THE ROYAL AIR FORCE

SERVICE NOTES AND NEWS AIR MINISTRY ANNOUNCEMENTS



FOR GENERAL PURPOSES: Built to the Air Ministry specification G. 4/31, this Pegasus-engined Parnall Biplane is in the General Purpose class and can be used for precision and dive bombing, torpedo dropping, etc. It embodies numerous unorthodox features, a number of which can be seen in the views on page 85. (*Flight* Photograph.)

SIR ROBERT BROOKE-POPHAM

Air Chief Marshal Sir Robert Brooke-Popham, temporary A.O.C., Middle East, has been involved in a motor accident in Kenya and broken his left arm. He has been detained in hospital at Nairobi. He had been inspecting a unit of the R.A.F. at Moyale in Kenya near the Abyssinian frontier when his car hit a boulder and overturned. He was flown to Nairobi.

VICE-ADMIRAL, AIRCRAFT CARRIERS

The Admiralty announce that Rear-Admiral the Hon. Sir Alexander R. M. Ramsay, K.C.V.O., C.B., D.S.O., has been appointed Vice-Admiral, Aircraft Carriers, on promotion to Vice-Admiral, to date January 2, 1936.

Sir A. Ramsay completed his two years in command of aircraft carriers at the end of last August, and was to have been succeeded by Rear-Admiral N. F. Laurence, C.B., D.S.O. This change has been postponed owing to the international situation. H.M.S. *Courageous*, the flagship, is in the Mediterranean.

PERMANENT COMMISSIONS FOR MEDICAL OFFICERS

The undermentioned medical officers have been selected for permanent commissions, subject to physical fitness:—

Flight Lieutenants:—Hugh Bannerman, M.B., B.S., Francis Wilfrid Peter Dixon, M.B.E., M.B., B.S., and Colin Russell Palfreyman, M.B., B.S.

R.A.F. BENEVOLENT FUND

The usual meeting of the Grants Committee was held at Iddesleigh House on Monday, January 13. Mr. W. S. Field was in the chair, and the other members present were: Mrs. L. M. K. Pratt Barlow, O.B.E., Air Comdre. B. C. H. Drew, C.M.G., C.B.E., Wing Com. C. E. H. James, M.C., Air Vice-Marshal C. A. H. Longcroft, C.B., C.M.G., D.S.O., A.F.C. The Committee made grants to the amount of £322 2s. The next meeting was fixed for Monday, January 27.

SPECIALIST PHOTOGRAPHIC COURSE

The undermentioned officers, having successfully completed the specialist photographic course at the School of Photography, South Farnborough, which terminated on October 31, 1935, are granted the symbol "Ph": Flt. Lt. A. H. Seymour-Lucas and F/O. M. B. Edwards.

SPECIALIST TORPEDO COURSE

The undermentioned officers, having successfully completed the torpedo course which terminated on November 29, 1935, following the specialist E course at Henlow, are granted the symbol E (T): Flt. Lts. G. F. Alexander and B. N. Matson.

No. 13 (A.C.) SQUADRON

The coming-of-age dinner of No. 13 Squadron, R.F.C. and R.A.F., will be held at the Royal Air Force Club, 128, Piccadilly, on Friday, January 31, 1936, at 8 o'clock for 8.30. Any officer who has served in the unit and wishes to attend, but has not yet accepted, is requested to write to the Mess Secretary, No. 13 (A.C.) Squadron, R.A.F., Old Sarum.

MOVES CANCELLED

The movement of No. 57 (Bomber) Squadron from Upper Heyford to Catterick, and the formation at Upper Heyford of the new No. 83 (Bomber) Squadron on January 14, have been cancelled.

No. 4 F.T.S. ABU SUEIR

The undermentioned officers and airman pilots have been awarded special assessments, as shown hereunder, on completion of a course of *ab initio* flying training at No. 4 Flying Training School:—

Distinguished Pass

A.P/O.s R. T. F. Gates and V. A. Pope.
A./Sgts. Munn, W. S., Gold, J. S. D., and Myers, J. T.

FOREIGN OFFICER WITH THE R.A.F.

Lt. Afkhami, of the Iranian Air Force, is undergoing the Instructors' Course at the Central Flying School, which commenced on January 13.

ROYAL AIR FORCE GAZETTE

London Gazette, January 14, 1936

General Duties Branch

Air Comdre. W. S. Douglas, M.C., D.F.C., is appointed Director of Staff Duties, Air Ministry, vice Air Vice-Marshal A. S. Barratt, C.M.G., M.C. (January 1); Lt. Cdr. L. G. Richardson, R.N., is reattached to the R.A.F. as a Squadron Leader, with effect from January 6, and with seniority of January 1; F/O. D. G. Morris is promoted to the rank of Flight Lieutenant (December 27, 1935).

The following Pilot Officers are promoted to the rank of Flying Officer (December 6, 1935):—F. C. Richardson, N. de W. Boult, W. A. Theed.

Wing Cdr. F. W. Stent, M.C., is placed on the retired list at his own request (January 15).

The short service commissions of the following Acting Pilot Officers on probation are terminated on cessation of duty on the dates stated:—N. T. Ingham, M. H. T. Mellish, R. D. More (January 5); W. H. Phelan (January 7).

Dental Branch

F/O. A. Maben, L.D.S., is promoted to the rank of Flight Lieutenant (January 7).

ROYAL AIR FORCE RESERVE

Reserve of Air Force Officers

General Duties Branch

F/O. W. F. Hilchie is transferred from Class A to Class C (December 7, 1935).

The following are transferred from Class B to Class C on the dates stated:—Sqn. Ldr. G. L. Hunting (October 16, 1935); Flt. Lt. R. C. Bryant (October 27, 1935).

F/O. C. G. Davies is transferred from Class C to Class A (January 10).

SPECIAL RESERVE

General Duties Branch

R. A. Lowe is granted a commission as Pilot Officer on probation (December 1, 1935); P/O. D. C. Badger relinquishes his commission on grounds of ill-health (January 15).

AUXILIARY AIR FORCE

General Duties Branch

No. 600 (CITY OF LONDON) (FIGHTER) SQUADRON.—C. J. Mount is granted a commission as Pilot Officer (November 23, 1935); Flt. Lt. G. F. Anderson relinquishes his commission on completion of service (November 10, 1935).

No. 602 (CITY OF GLASGOW) (BOMBER) SQUADRON.—F/O. J. S. Feather is promoted to the rank of Flight Lieutenant (November 26, 1935).

No. 607 (COUNTY OF DURHAM) (BOMBER) SQUADRON.—The following Pilot Officers are promoted to the rank of Flying Officer:—W. E. Gore (December 18, 1935); S. W. Kaye (December 1, 1935).

AUXILIARY AIR FORCE RESERVE OF OFFICERS

General Duties Branch

G. F. Anderson is granted a commission as Flight Lieutenant in Class A (November 10, 1935).

ROYAL AIR FORCE INTELLIGENCE

Appointments.—The following appointments in the Royal Air Force are notified:—

General Duties Branch

Air Commodore.—T. L. Leigh-Mallory, D.S.O., to Headquarters, R.A.F., Iraq, Hinaidi; for duty as Senior Air Staff Officer vice Air Vice-Marshal E. L. Gossage, D.S.O., M.C., 6.12.35.

Group Captain.—H. V. Champion de Crespigny, M.C., D.F.C., to No. 8 Flying Training School, Montrose; to command, 1.1.36.

Wing Commanders.—H. H. MacL. Fraser, to No. 1 School of Technical Training (Apprentices), Halton; for Administrative duties and to command No. 4 Apprentices Wing, 1.1.36. H. V. Drew, O.B.E., A.F.C., to No. 99 (B) Squadron, Mildenhall; to command, 1.1.36. C. R. Cox, O.B.E., A.F.C., to No. 209 (F.B) Squadron, Felixstowe; to command, vice Wing Cdr. G. E. Livock, D.F.C., A.F.C., 6.1.36. D. Iron, O.B.E., to R.A.F. Station, Eastleigh; to command vice Wing Cdr. A. D. Pryor, 8.1.36.

Squadron Leaders.—C. L. Lea-Cox, to No. 56 (F) Squadron, North Weald; to command, 1.10.36. S. F. Vincent, A.F.C., to R.A.F. Station, Northholt; for Armament duties, 1.1.36. A. H. Paull, A.F.C., to No. 100 (T.B.) Squadron, Singapore; to command, vice Sqn. Ldr. L. G. Le B. Croke, 18.11.35. W. A. B. Bowen-Buscarlet, D.F.C., to No. 10 Flying Training School, Ternhill; for duty as Chief Flying Instructor, 1.1.36. H. J. Gemmel, to No. 8 Flying Training School, Montrose; for Administrative duties, 2.1.36. W. J. Millen, to R.A.F. Station, North Coates Fitties; for Administrative duties, 2.1.36. J. R. Cassidy, to Electrical and Wireless School, Cranwell; for Signals duties, 6.1.36. T. Humble, to No. 16 (Army Co-operation) Squadron, Old Sarum; to command, 1.1.36. H. A. L. Pattison, to Electrical and Wireless School, Cranwell; for Signals duties, 5.1.36. J. W. Turton-Jones, to No. 19 (F) Squadron, Duxford; to command vice Sqn. Ldr. J. R. Cassidy, 6.1.36.

Flight Lieutenants.—H. L. Messiter, to R.A.F. Station, North Coates Fitties, 2.1.36. J. B. Tatnall, to No. 8 Flying Training School, Montrose, 1.1.36. R. C. Field, to No. 16 (Army Co-operation) Squadron, Old Sarum, 5.1.36. J. F. F. Pain, to School of Army Co-operation, Old Sarum, 5.1.36. H. E. Nowell, to Aircraft Depot, Karachi, India, 3.12.35. G. Harcourt-Smith, to Headquarters, Fighting Area, Uxbridge, 4.1.36. J. N. Jaques, to No. 6 Flying Training School, Netheravon, 6.1.36. T. B. Bruce, M.C., to No. 39 (B) Squadron, Risalpur, India, 15.12.35.

Flying Officers.—E. S. Butler, to R.A.F. Station, Bircham Newton, 1.1.36. A. H. Fear, to Air Observers School, Manston, 1.1.36. A. W. Geoghegan, to R.A.F. Station, Bescombe Down, 1.1.36. M. F. D. Williams, to R.A.F. Station, Gosport, 1.1.36. H. P. Jenkins, to School of Photography, South Farnborough, 6.1.36. F. A. A. H. Strath, to No. 24 (C) Squadron, Hendon, 2.1.36. G. E. Valentine, to No. 26 (Army Co-operation) Squadron, Catterick, 2.1.36. G. D. M. Blackwood, to No. 600 (City of London) (F) Squadron, Hendon, 6.1.36. M. V. Gibbon, to No. 604 (Co. of Middlesex) (F) Squadron, Hendon, 6.1.36. J. K. Rotherham, to No. 605 (Co. of Warwick) (B) Squadron, Castle Bromwich, 6.1.36. E. R. Pearce and R. G. Shaw, to Home Aircraft Depot, Henlow, 5.1.36.

Acting Pilot Officers.—The following are posted to No. 7 Flying Training School, Peterborough, with effect from 4.1.36:—L. E. Abel, R. H. Adams, R. W. Aitken-Quack, F. D. Beales, R. Bickford, G. K. Buckingham, D. H. Burnside, V. S. Butler, R. B. Carr, K. C. Doran, A. G. Duguid, A. J. Elliott, B. D. Griffin, H. M. Hammond, C. H. Heber-Percy, L. C. Jones-Bateman, M. N. McF. Kennedy, C. B. Lamb, R. D. B. MacFadden, W. D. Morford, V. R. Paterson, C. S. H. Richardson, G. A. W. Saunders, K. H. Savage, J. S. Scott, K. G. Sharp, B. S. Tomlin, J. Walmisley, W. L. Warner, J. P. M. Woolley, and J. C. Richards.

Stores Branch

Flight Lieutenants.—A. Connock, to No. 2 Mechanical Transport Storage Unit, Kenley, 2.12.35. G. G. C. Pigott, to R.A.F. Station, Singapore, 29.12.35.

Flying Officers.—B. H. Alder, to R.A.F. Station, Gosport, 6.1.36. A. C. Dibben, to Home Aircraft Depot, Henlow, 6.1.36. L. Doyle, to Aeroplane and Armament Experimental Establishment, Martlesham Heath, 6.1.36. C. D. P. Franklin, to Headquarters, R.A.F. Halton, 6.1.36. E. H. Free, to No. 3 Stores Depot, Milton, 6.1.36. J. G. B. O'Hagan, to Administrative Wing, Cranwell, 6.1.36.

Pilot Officer.—S. G. Walker, to Headquarters, R.A.F., Cranwell, 21.12.35.

Medical Branch

Wing Commanders.—P. T. Rutherford, O.B.E., to Headquarters Fighting Area, Uxbridge; for duty as Principal Medical Officer, vice Group Capt. K. Biggs, M.C., 7.1.36. E. C. K. H. Foreman, to No. 10 Flying Training School, Ternhill; for duty as Medical Officer, 1.1.36.

Squadron Leader.—C. A. Lindup, to No. 8 Flying Training School, Montrose; for duty as Medical Officer, 1.1.36.

A FLIGHT that LIVES

Pioneers Gather in Paris to Celebrate the 25th Anniversary of the London-Manchester Contest Between Paulhan and Grahame-White

AT THE BANQUET : Among those at the top table are M. Louis Breguet (fourth from right), Col. O'Gorman (sixth), M. Tissandier, Secretary-General of the F.A.I. (eighth), Louis Paulhan (tenth) and Gen. Denain (extreme left). In the foreground, seated at the "1910 pilots'" table, are M. Henry Farman (left), with Mr. Claude Grahame-White on his right ; then come M. Henri Jullerot and, facing the camera, is Lt. Col. Moore-Brabazon.

THE story of the struggle for the honour of making the first London-Manchester flight in twenty-four hours, and thereby winning *The Daily Mail* £10,000 prize, is one that will always be outstanding in the annals of aviation; even to-day twenty-five years later, many remember almost every detail of the epic struggle between M. Louis Paulhan and Mr. Claude Grahame-White on their Henry Farman biplanes; there was, indeed, drama in the air on the night of April 27, 1910, when Paulhan, thinking he had plenty of time in hand, slept peacefully in an hotel at Lichfield oblivious to the fact that his rival, having triumphed over a series of cruel setbacks was fighting his way through wind, rain and darkness only thirty-four miles distant.

Hastily awakened, the Frenchman scrambled into his seat and took off; and only ten miles away, at the same moment, the Englishman once more fell foul of Fortune, being finally and literally forced to earth by the strength of the wind, while the other continued to the finish.

It was to celebrate the twenty-fifth anniversary of this great event that the Aero Club of France, in Paris last Thursday, gave a banquet in honour of Paulhan. The affair was organised in conjunction with the *Vieilles Tiges* ("Old Timers."

The French Air Minister, General Denain, presided, and, in addition to Louis Paulhan, the guest of honour, those at the top table included Prince George Bibesco, President of the F.A.I.; Prince Berthold of Sweden; MM. Andre Wateau, President of the Aero Club of France; Laurent-Eynac, former Under Secretary of State for Aviation and now Minister of Public Works and President of the Federation Aeronautique de France; Leon Bathiat, President of the *Vieilles Tiges*; Georges Dorman, former Minister of Pensions; and Generals Pujo (chief of Air Force) and de Vergniette and Gerard.

In addition to Mr. Claude Grahame-White, British aviation was represented by Colonel Mervyn O'Gorman, Vice-President of the Royal Aero Club and of the F.A.I.; Comdr. H. E. Perrin, Secretary of the R.Ae.C.; Lieut. Col. Moore-Brabazon, holder of British pilot's licence No. 1; Wing Comdr. Field, British Air Attache in Paris; and Captain K. Bartlett.

Pilots and constructors of the pre-War era were seated together at a long table; they included MM. Henry Farman, Voisin, Breguet, Caudron, Bleriot and Anzani.

M. Andre Watteau, welcoming the guests, said that the London-Manchester flight might be looked on as a milestone from which the progress not only of private aviation but also of military aviation might be said to date. M. Bathiat entertained the company with anecdotes of the early days, and concluded by giving an account of the London-Manchester flight.

M. Henri Kapferer (a balloonist of the 1910 era), Prince George Bibesco and General Denain then spoke briefly, relating further anecdotes of that period, and M. Paulhan closed the speech-making with a few well-chosen observations concerning the great progress effected in aeronautics since 1910. He also paid an especial tribute to Mr. Grahame-White's sportsmanship.

Forthcoming Events

Jan. 28. R.Ae.S. Students' Section Discussion: "Sailplanes," 7 p.m., R.Ae.S. Library, 7, Albemarle Street, London, W.1.

Jan. 30 and 31. Aerodrome Owners' Association: Annual Conference and Aerodrome Equipment Exhibition, British Industries House, Marble Arch, London.

Feb. 3. R.Ae.S. Lecture: "Airscrew Development" by Dr. H. C. Watts. Institution of Electrical Engineers, 6.30 p.m.

Feb. 12. Yorkshire Aviation Services Country Club: Dinner and Dance, 8 p.m., Grand Hotel, Harrogate.

Feb. 13. R.Ae.S. Students' Section Lecture: "Light Aeroplane Design and Construction," by Dr. N. A. de Bruyne, 7 p.m., R.Ae.S. Library, 7, Albemarle Street, London, W.1.

Feb. 17. R.Ae.S. Lecture: "The Boundary Layer," by Prof. L. Bairstow. Institution of Electrical Engineers, 6.30 p.m.

Feb. 20. R.Ae.S. (Coventry Section) Lecture: "Variable-pitch Airscrews," by Mr. T. E. Beacham, 8 p.m., Armstrong Siddeley Canteen.

Feb. 21. Croydon Airport Staff Dinner and Ball, Greyhound Theatre, Croydon, 7.45 p.m.

Feb. 21. D. H. Aeronautical Technical School: Annual Dance, Hyde Park Hotel, London, 9 p.m.

Feb. 25. R.Ae.S. Students' Section Lecture: "Mechanical Testing of Structures and Components," by W. Tye, 7 p.m. R.Ae.S. Library, 7, Albemarle Street, London W.1.

Feb. 27. Bristol and Wessex Aeroplane Club: Annual Aviation Ball.

TO BENEFIT MARKSMANSHIP

First Details of the Armstrong-Whitworth Gun Turret : Wide Application : Adopted by R.A.F.

Installation of the turret in the tail of the A.W. XXIII.

TWO new military aeroplanes—the A.W. XXIII bomber-transport and the Avro Anson coastal reconnaissance machine—attracted no little attention in the New and Experimental Types Park at last year's R.A.F. Display. Outstanding among their numerous modern features were gun turrets of a type not previously familiar to the public. Products of Sir W. G. Armstrong Whitworth Aircraft, Ltd., these turrets were fitted in the nose and tail of the big A.W. and one amidships on the Anson. On the latter type the A.W. gun turret has become standard equipment in the Royal Air Force.

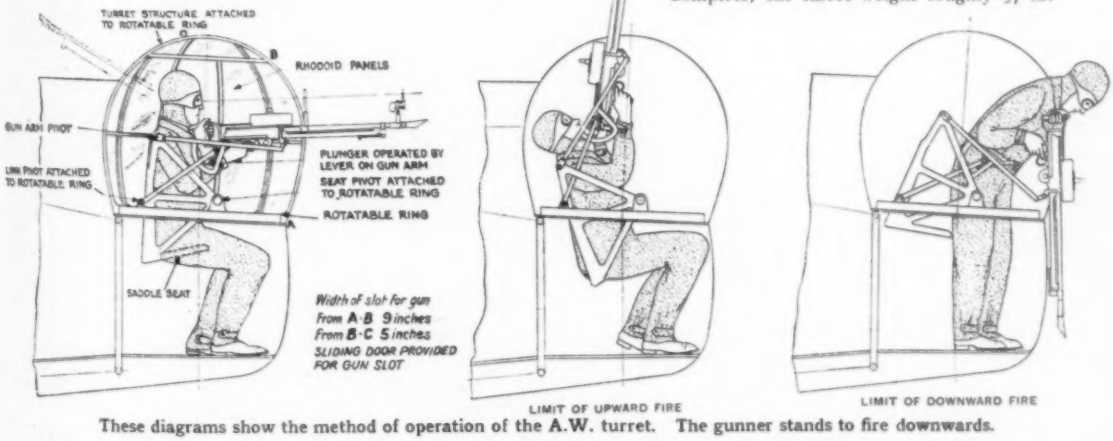
The turret was designed to provide a mounting for a free gun on high-speed aeroplanes, and is applicable to nose, amidships and aft gun positions. Briefly, its purpose is to protect the gunner and to enable the gun to be trained with a minimum of physical effort. A seat is provided for the gunner, who has his weight balanced against that of the gun. There is a special link motion whereby the gunner's line of vision remains in the same relation to the gun sights throughout the entire range of elevation. It is claimed that the balancing of the mechanism completely overcomes the effect of accelerations during manœuvres. To fire vertically downward the gunner stands, and the weight of his gun is taken directly on the mounting.

Operation is entirely manual. The turret rotates on rollers on a vertical track, rotation being effected by reaction from the gunner's feet on the rubber-covered cockpit floor. A mechanical lock is fitted to enable the turret to be locked at any desired angle or traverse. Merely leaning backward or forward is sufficient to alter the elevation, and in practice, it is said, this movement is quite natural, demanding no mental effort by the gunner. A small movement on the seat conpensates for the varying weight of gunners.

Although independent locks are provided for both the rotational and elevating movements, it has been found in practice that the gun can be fired with the entire mechanism free, no ill effects being experienced from recoil. It is possible, therefore, to follow a target continuously.

The only external unbalanced force is that caused by the protrusion of the gun barrel. Firing aft, and through a horizontal traverse of 60 degrees on each side, it is claimed, no inconvenience is experienced at any speed. When firing fully broadside, however, the gun barrel creates a rotational force which must be resisted by the gunner.

Substantially of spherical formation, the turret casing consists of a metal framework and suitably formed Rhodoid panels. The slot through which the barrel of the gun protrudes is fitted with an articulated sliding cover allowing the turret to be completely sealed when the gun is not in use. Complete, the turret weighs roughly 97 lb.


TURRET STRUCTURE ATTACHED TO ROTATABLE RING
RHODOID PANELS
GUN ARM PIVOT
LINK PIVOT ATTACHED TO ROTATABLE RING
PLUNGER OPERATED BY LEVER ON GUN ARM
SEAT PIVOT ATTACHED TO ROTATABLE RING
ROTATABLE RING
SADDLE SEAT
Width of slot for gun
From A-B 9 inches
From B-C 5 inches
SLIDING DOOR PROVIDED FOR GUN SLOT
LIMIT OF UPWARD FIRE
LIMIT OF DOWNWARD FIRE

These diagrams show the method of operation of the A.W. turret. The gunner stands to fire downwards.

The R.A.F. Book

"WELL-PRODUCED, and packed with extraordinarily vivid pictures, the volume must make an irresistible appeal to boys of all ages up to 80." That is the opinion of the *Sunday Times* reviewer about the *Flight* book, *Squadrons of the Royal Air Force*, and it is typical of the numerous reviews which have appeared in leading journals.

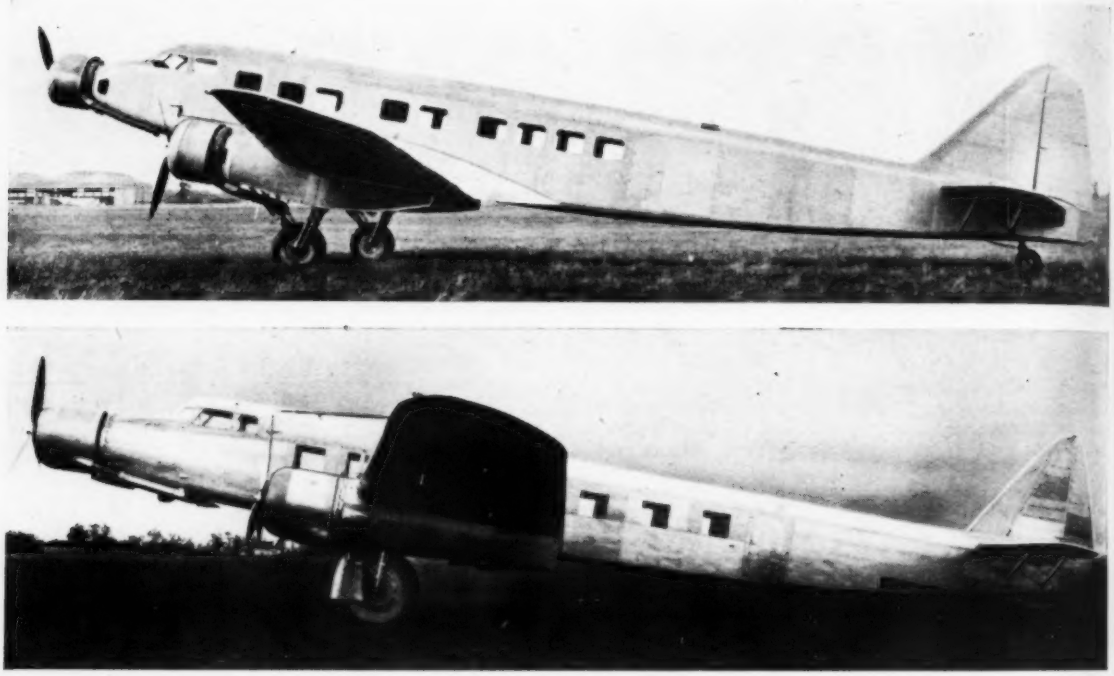
The expansion of the Royal Air Force goes steadily on, and thousands of applications are pouring in to the Air Ministry and the recruiting offices. This book will tell prospective officers and airmen all about the great Service of which they hope to become members.

Airwork on the Continent

MR. R. L'ESTRANGE MALONE, Airwork's European sales manager, is to tour the Continent for about two months in a D.H. Hornet Moth, for contact and demonstration purposes. He is due to leave in three to four weeks' time, and will commence with a visit to Spain and Portugal. The tour, which is to finish in Scandinavia, will probably include all European countries excepting Italy. Continental aero clubs, air transport companies, and private pilots interested in any type of British aircraft will be assured of special attention if they write their requirements to the Airwork sales department, Heston Airport, London, at the earliest possible date.

COMMERCIAL AVIATION

— AIRLINES — AIRPORTS —



CONTINENTAL : These are the most recent French efforts at building thirty-passenger transports. Their similarity may be accounted for by the fact that they were both designed to meet the requirements of Air France. The top one is the Bloch 300 or "Pacifique" and the other the Dewoitine D-620. Both have three Gnome-Rhone Mistral Majors, moderately supercharged to give 880 h.p. at 6,500 feet. Maximum speeds are estimated to be in the neighbourhood of 220 m.p.h.

THE WEEK AT CROYDON

Getting Above It : An Interesting Anomaly : Mail Transport : Many Methods : Travelling Comfort

WEEK after week it seems that I have to record the worst week's weather we have ever experienced. Last week again broke most records. "Front" after "front" swept over us, each as unpleasant in its way as any front in Ethiopia. There were gales, snow and sleet, fog, and, of course, ice formation.

One Swissair pilot, tiring of this state of affairs, went up to *18,000ft.* to avoid all the unpleasantness below. He got above it all, into perfect weather, and when he reported the height at which he was flying an amazed Control Tower asked for the message to be repeated. The sort of weather we have had caused the D.L.H. London-Amsterdam-Berlin machine to set off on Saturday last for an unknown destination. Amsterdam and Rotterdam were very bad, and the pilot, before leaving, stated that he would make for Cologne or Frankfurt if it proved impossible to reach Holland.

On Sunday the K.L.M. outward service to Holland could not make Amsterdam, and landed at the emergency airport of Twente, in Holland, and the inward service to England was operated from the same place. It simply shows how necessary are adequately equipped emergency airports in every country if services are to be maintained in difficult conditions.

Much interest has been aroused by the case of alleged smoking in an Imperial Airways machine homeward bound from Paris, when, it is said, a passenger refused to obey the steward's hint, and smoked on four separate occasions, even though interviewed by the captain himself. It is said that there is to be a prosecution—some people think by the Air Ministry under the provisions of the Air Navigation Act—but others, more logically, it would seem, think that it is the part of the operating company to prosecute. If nothing *is* done, then goodbye to all control in this matter.

It would be useful if the position of the captain or commander of an air liner having wheels—in other words, a landplane—could be clearly defined and definitely established. It appears that if a pilot is in command of a flying-boat or seaplane, he is in charge of a marine craft, and has the same powers as any other ship's captain. He can, presumably, put a passenger in irons, and, for all I know, "yard-arm" or "keel-haul" him, to say nothing of causing him to wing-walk, the modern equivalent of walking the plank. The same pilot in charge of even the biggest air liner that ever landed on wheels has, apparently, no powers whatsoever, and it may be that if he landed *en route* to put off a refractory passenger he could be sued

for breach of contract. All this is supremely ridiculous, and if ships' practice in this matter holds good for flying-boats, what about the powers of the drivers and/or guards of stage coaches and railway trains? Why do these not hold good for flying coaches? Anyway, what about a pilot in charge of an amphibian? The remedy for the whole thing lies in the provision of separate smoking compartments, and these, I hear, will be provided on the new Imperial Airways fleet.

People get hold of the wrong end of the stick in this matter. Under proper supervision—of the steward, for example—there is no danger in the practice, especially if the furniture, carpets, fittings, and so on, are all fire-proofed. The trouble, in machines of to-day, is the effect on non-smokers, who, after all, like teetotallers, are also human beings.

I understand that the G.P.O. will, in future, definitely meet inward K.L.M. services with post office transport for mails, as these have grown too bulky for transport to London by passenger coach. Certain Imperial Airways services have been served by G.P.O. vans for quite a long time, I believe.

There is some excitement about the alleged wireless beacon, or perhaps I should say the alleged erection of a wireless beacon at Croydon. This is thought to be an Air Ministry invention, based on the Lorenz system, and everybody firmly believes it will be quite as good as the German system—when it has been in operation as long as the Tempelhofer device. Three systems are said to be under consideration, one of them the Lorenz, at Heston, and two others, one to be installed at Croydon and the other at Gatwick. Some "fine confused flying" should result from all this until things ultimately settle down.

After a trip from London to Karachi (on the Amsterdam-Batavia line), Ronald Green, a schoolboy, wrote: "I enjoyed every minute of the trip. The plane was very comfortable, and the crew looked after me jolly well all the way out." Air companies, especially on the longer trips, have certainly established a splendid reputation with the travelling public of all types and ages.

The "Rollason men" look peaked and wan through overwork when you see them gulping a hasty cup of tea in the buffet. They tell me that they have just installed new machinery in the shape of a spindling machine, and also a shaping machine, and that they are now fully equipped for all woodwork, and, incidentally, are very busy with orders in that particular line. [Other interesting work is mentioned on the following page.—ED.]

During last week's severest spell a hare came on to the tarmac and had a nose-to-nose inspection of the Commercial Air Hire Avro 642, the only other creature out and about at the time.

A. VIATOR.

France's Loss

IT would appear that France's hope that she might be the first country to fly an experimental North Atlantic service has been finally dashed. The Latécoère flying boat *Lieutenant de Vaisseau Paris* was sunk by a sudden gale while moored in Pensacola Bay, in Florida.

Fortunately, no one was on board at the time, but the machine according to report, has been fairly extensively damaged, since it flew like a kite at the end of its cable before plunging to the bottom. Only three weeks ago the *Lieutenant* flew the South Atlantic.

The American Disaster

WITH the customary promptitude of the U.S. accident reports, we shall probably learn quite soon of the probable reasons for the appalling disaster which overtook the Douglas flying on American Airlines' New York-Los Angeles run with fourteen passengers. The machine had left Memphis and was on its way towards Little Rock when it crashed in a swamp near Goodwin, Arkansas.

For the present there is evidence, in the form of fastened safety belts and cut switches, to show that the pilots had foreseen the possibility of a forced landing. Since, with the help of head lights, some sort of hold-off would have normally been attempted, the extent of the damage suggests very serious trouble.

The Sikorsky Project

THE need for co-operation between shipping and air interests and the importance of air transport in the matter of international trade recovery were the two points expanded by Mr. W. Craven-Ellis, M.P., who took the chair last Friday at a luncheon given at the Savoy Hotel in connection with British Marine Aircraft's plans.

This company, a subsidiary of Aircraft Industries Corporation, will, it will be remembered, build Sikorsky flying boats in this country, and the site for the works has already been purchased near Southampton—one actually adjoining the Air Service Training headquarters at Hamble. Mr. Craven-Ellis mentioned that the initial output of five Sikorsky S.42A boats had already been ordered—by Marine Airways, as a matter of fact. No details are yet available concerning the plans of this company, which is being sponsored by British Pacific Trust.

Sir Philip Dawson, M.P., also spoke of the importance of the flying boat both for Imperial communications and for military purposes, while Air Marshal Sir John Higgins explained that this country, in common with the whole of the Empire, was particularly interested in the development of the long-distance flying boat.

Lt.-Col. Moore-Brabazon, who was to have taken the chair, was detained in Paris in connection with the 1910 London-Manchester air race celebrations.

Dawn Regularity

THE recent bad weather has had little effect on the regularity of Air Dispatch's Paris "Dawn Express," and the company reports that this was the only regular service to operate from Croydon to Paris and return without a single cancellation during last week. The pilots, Messrs. Eric Noddings and S. W. A. Scott, may well feel proud of themselves. On one morning the Avro 642 was the only machine to leave Croydon.

This hundred per cent. service earned the company a word of appreciation from The Gramophone Co. (H.M.V.), who have recently arranged for the "Dawn Express" to carry all their Paris freight—which averages several thousand kilos of valuable and fragile goods every month. Air Dispatch has also contracted to carry daily consignments of gold for Samuel Montague and Co. and Japhet and Co., in addition to consignments of platinum for Derby and Co.

Tatsfield and Alexandria

JUDGING from the evidence given at the inquest last week on the eleven victims of the Savoia-Marchetti crash at Tatsfield, it appears that the possible causes given in *Flight* at the time of the accident were not so far from the mark.

The machine was being "homed" by means of D/F bearings given by the Croydon operators and by means of its own D/F receiver on regular transmissions from Croydon. Major Cooper's theory was that the pilot, having over-estimated his rate of progress, came down too soon, realised that he was in a valley and flying towards rising ground, pulled the nose up and stalled the machine. Since the use of full throttle should normally have saved the machine even at the very last moment, it appeared to be possible that ice formation in the carburetters might have been a contributory cause. However, Major Cooper, in his evidence, ruled out this possibility and stated that the engines were fitted with adequate induction heaters.

Meanwhile, several disturbing points had cropped up at the resumed inquest on the victims of the *City of Khartoum* disaster.

It appears that the lights of the machine were first seen, or thought to be seen, soon after 7.15 p.m. The station superintendent, however, was the first to get in touch, indirectly, with the naval authorities—at 8.15 p.m.—and the first ship, H.M.S. *Beagle*, put to sea at 9.15 p.m. H.M.S. *Brilliant* left at 12.36 a.m. and picked up Capt. Wilson at 12.50.

Apart from the inevitable time taken in putting to sea, there appeared to be a good deal of delay in acting on the obvious fact that the *City of Khartoum* was overdue, and on the apparently unreported fact that its lights had been seen. Later on it was stated that ten gallons of petrol had been taken off at Athens in order to allow for an extra load. The buffet load was about the maximum ever carried. The *City of Stonehaven*, a sister ship, landed at Alexandria the same evening with only seventeen gallons of fuel in her tanks.

Commercial Aviation

Imperial Training

ROLLASON AIRCRAFT SERVICES have recently been at work on an interesting conversion job. One of the Westland Wessex machines owned by Imperial Airways has been suffering certain nasal changes in order to accommodate dual control, which has been ingeniously arranged by forking the original column and by adding another spectacle control.

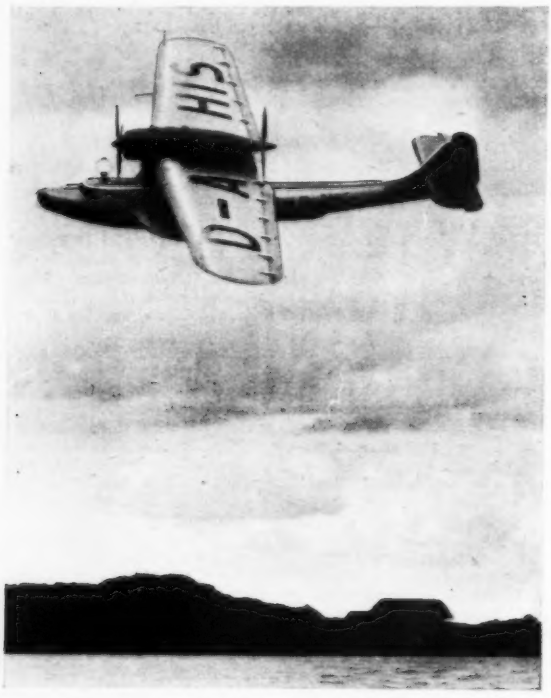
The machine is to be used for wireless training purposes by Imperials—presumably in connection, too, with the blind approach system, which Croydon may or may not have during the next year or so. Whilst Probationary First Officer Blank is receiving approach instruction in the second pilot's seat, other officers will be able to disturb the imaginary ether from the security and comfort of the cabin behind. (What, by the way, are the four mobile D/F stations doing in the Rollason hangars?)

Rollason's are also helping in the work of rebuilding the Atalanta which was wrecked at Kisumu last year, and the shops are chock-a-block with aeroplanes, light and heavy, in various stages of repair. One hears, too, that the Hanworth shops are also very busy. It is nice to think that the private owners' little misfortunes bring good to somebody.

Short-Wave Approaches

WITHIN a week the Lorenz blind-landing system, which is being installed at Heston, should be in experimental working order. Mr. Jeffs, the chief control officer, has obtained the temporary services of an experienced German pilot, who is to bring a Ju.52 over for a demonstration. Meanwhile, only one machine in this country, the D.H. Dragon which is being fitted out as a flying laboratory for Smith's Aircraft Instruments, is likely to be useful.

However, several of the British Continental Airways machines are to be so fitted, and one or two pilots will soon be going over to Tempelhof for their training. Mr. Farey Jones and Mr. Morton, the company's chief pilot, were very much impressed with the demonstrations given to them (in genuine Q.B.I. conditions!) while they were in Germany, and, in any case, most of the airports and intermediate airports which will be on the Scandinavian route are Lorenz-equipped.



FOR SOUTHERN SERVICE: The *Monsun*, first of the Dornier Do. 18 boats for the German South Atlantic mail service. A range of 2,765 miles is claimed at a cruising speed of 124 m.p.h. Two 500/560 h.p. Junkers Jumo diesels are fitted, the rear one driving its propeller through shafting. This machine was first illustrated in *Flight* of November 14.

The Chamber of Air Commerce

AT a meeting last week of the Civil Aviation Section of the London Chamber of Commerce, Mr. H. N. St. V. Norman was elected chairman for the year 1936 in succession to Viscount Ratendone, whilst Air Vice-Marshal A. E. Borton, C.B., C.M.G., D.S.O., A.F.C., was elected as deputy-chairman.

Manchester's Airport

THE Manchester Corporation has, it appears, been rather taken aback by the refusal of the Air Ministry to remove the meterological and radio station from Barton to the new airport at Ringway. Presumably, the Ringway airport will now have to be equipped with a short-wave beacon, so that machines after being brought into the area by D/F from Barton will still be able to reach Ringway in thick weather.

Work at Ringway, incidentally, has been held up recently by the deep snow.

An American Profit-earner

AT the time when the first details of the three-motor Stinson "Airliner" were published in *Flight* of March 29, 1934, this machine caused some interest, inasmuch as it appeared to be one with which unsubsidised operation might be possible even in this country.

Some time ago Brian Allen Aviation, Ltd., of Croydon Airport, were appointed sole concessionaires for this machine, which in its latest form, and with fixed-pitch airscrews, cruises at 152 m.p.h. at 9,000 ft. with ten passengers and baggage. Its take-off run is 970 ft., its rate of climb is 800 ft./min., and its service ceiling is 15,000 ft.—or, with one outboard engine out of action, 5,000 ft. Three Lycoming R-680-2 240 h.p. engines are fitted, and the normal maximum range is 650 miles.

This Stinson is actually available in two forms—with or without dual control—and the actual payloads for each are 2,110 lb. and 2,320 lb. respectively, with an all-up weight of 9,950 lb.

The standard equipment includes complete radio shielding and bonding and Grimes navigation lights. Controllable-pitch airscrews may be fitted without a reduction in the useful load. The price in this country will be in the region of £11,000.

More Anglo-Dutch Enterprise

THE first direct air service from the North of England to the Continent to be operated regularly by a British firm is announced for next summer by British Continental Airways, behind whom there are understood to be very big financial interests indeed.

Pursuing the policy of close co-operation with K.L.M.—a co-operation which already exists on the London-Amsterdam route—this northern route will be operated daily by the two companies, who will run alternate services.

The route will not be exactly the same as that flown for the last two summers by K.L.M. Next summer the line from Liverpool will be *via* Doncaster, which is not only more direct but also takes advantage of the fact that Doncaster may be described as the railway nerve-centre of the Yorkshire manufacturing districts, and thus gives the maximum facilities for passengers and freight.

The Doncaster Corporation has been sufficiently enterprising to push energetically forward with plans for enlarging its airport and for providing every modern facility to attract air traffic. It is pleasant to see that this enterprise has won its natural reward, for it is not always easy to convince municipal authorities that a city gets, or will get in the future, the air traffic its airport deserves.

This Anglo-Dutch enterprise will not only provide a long-felt want in this country, i.e., a British line operating alongside the foreign one which has held the field alone for too long, but it will also give the North of England an even better connection with Amsterdam and the large number of cities to which air lines radiate from Holland.

By the time the northern service comes into operation B.C.A. will, it is expected, have a service from London to Scandinavia, in which case it will be possible to "fly British" all the way to Copenhagen or Malmö, either from Croydon or from Liverpool and Doncaster.

It is understood that Capt. H. Spry Leverton, who was recently appointed a director of B.C.A., has just returned from a satisfactory visit to Doncaster, where arrangements have been completed on behalf of B.C.A. and K.L.M.

Syke Extension

THE route covered by the bi-weekly Skye service, which is now being run by Northern and Scottish Airways, has been extended to Askernish airport, South Uist.

New Zealand Opening

LAST week Union Airways opened their trunk service between Dunedin and Palmerston North, via Christchurch and Blenheim. A DH 86 left Palmerston North on January 15.

The Navigation Examinations

EXAMINATIONS for second class navigators' licences will be held between Monday and Wednesday, March 23-25, at H.M. Civil Service Commissioners, 6, Burlington Gardens, W.1; the British Aviation Directorate representative in Egypt, Heliopolis aerodrome; Scletar aerodrome, Singapore; and Karachi aerodrome, India.

Southend Changes

LAST week Mr. Humphrey Coysh, who is now with Mr. Brian Allen, was installed at Southend Airport as manager, and considerable developments there, in the way of sales and service, are to be expected. It will be remembered that Capt. Glover has left the Southend Club to take, eventually, a position with Airwork, and, since, Mr. Lawson has also left. It is probable that a D.H. Dragon will be used by Southend Flying Services during the coming season.

A Puss for Hire

A VERY completely equipped and nicely finished D.H. Puss Moth is available for hire, by the day or hour, at Croydon by Wrightways. In addition to a turn and bank indicator, this machine has full night flying equipment, including an adjustable landing headlight mounted beneath the engine. Its angle can be varied some thirty or forty degrees by means of a cockpit control.

This machine, therefore, is a particularly suitable one for use by "B" licence aspirants on their nocturnal ramblings between Lympne and Croydon—or even between Lympne and a street in Southend. The normal rates are £4 4s. a day or £2 2s. an hour, the insurance costs being included in each case—though not, presumably, night flying insurance.

Apart from their early morning newspaper service to Paris and sundry charter trips, Wrightways have been busy recently on the job of rebuilding a private owner's metal Moth. The D.H. Rapide in Wrightways' colours, which was seen at Croydon last week, is *not* part of a new fleet. Two faithful Dragons still carry the bulk of the work.

AIRPORTS AND THEIR EQUIPMENT.

IN conjunction with the Annual Conference and Aerodrome Equipment Exhibition of the Aerodrome Owners' Association, which takes place in London on January 30 and 31, next week's issue of *Flight* will be a Special Number devoted to the subject of Modern Airports and their Equipment.

This issue will contain a number of articles dealing with the layout and maintenance of airports and illustrating modern practice at home and abroad. The Airports Exhibition is not open to the general public, but a review of the exhibits of the sixty-odd firms taking part will be included in this Special AIRPORTS number.

Next Week Jan. 30 — FLIGHT — Price Sixpence

Mails—But No Radio

PROVIDED that D/F facilities are available at Inverness before May 1, Highland Airways hope to start a Glasgow-Inverness service, calling at Perth. It is expected that this service will leave Renfrew at about 8.30 a.m. with the return in the afternoon. The air journey will take little over an hour, including the Perth stop.

During the year, incidentally, Highland Airways' main route between Inverness, Wick and Kirkwall was operated with a regularity of 94 per cent.—which, when it is remembered that there are, as yet, no radio facilities and that the weather in that part of the world can be really bad, is an extremely good figure. "The mails must have radio" should be, and probably is the company's continued cry. 93,441 miles were flown in 1935.

CORRESPONDENCE

The Editor does not hold himself responsible for the views expressed by correspondents. The names and addresses of the writers, not necessarily for publication, must in all cases accompany letters intended for publication in these columns.

Commercial Efficiency

I WAS very interested in the article entitled "Assessing Commercial Efficiency," by Mr. E. N. B. Bentley.

I have applied Mr. Bentley's formula to a dozen of the smaller present-day British commercial aeroplanes, which are of some importance for feeder-line or taxi work.

The results are appended hereto, and the first thing that strikes one is the remarkable commercial efficiency attained by the Miles aeroplanes produced by Phillips and Powis.

It will be seen that not only do they occupy the first three places out of the twelve machines quoted, but they are also first by a handsome margin in their respective classes.

Another interesting point mentioned by the author and illustrated by my figures is the common mistake of judging aeroplanes by the top speed alone, as shown by the high efficiencies attained by such (relatively) slow machines as the Gipsy Major Falcon and the Heston Phœnix.

The one criticism that I would make of the comparative results obtained by this interesting formula is that no account is taken of the landing speed or speed range—an important factor which will have a considerable effect upon the commercial efficiency as determined by a formula based partly upon the top speed of the machine.

In fact, it would be interesting to see what coefficients of commercial efficiency would be attained by the Miles aeroplanes if their wing areas were reduced until their landing speeds were as great as those of some of the machines quoted by Mr. Bentley. D. W. BROWN, Assoc.M.Inst.C.E., A.F.R.Ae.S.

Hove.

Machine.	H.P.	Price. £	Top Speed.	Passengers.	P × V / H.P.	P / £	Commercial Efficiency.
Falcon	130	1,000	148	3	3.415	3.000	6.415
Peregrine	380	4,203	188*	8	3.958	1.905	5.863
Merlin	190	1,650	160	4	3.368	2.424	5.792
Rapide	380	4,300*	160	8	3.368	1.860	5.228
Phœnix	190	1,980	145	4	3.053	2.020	5.073
Vega Gull	190	1,650*	170	3	2.684	1.818	4.502
Monospar	180	1,750	140	3	2.333	1.714	4.047
Gull	130	1,275	150	2	2.308	1.569	3.877
Eagle	130	1,250	148	2	2.277	1.600	3.877
Leopard	130	1,275	138	2	2.123	1.569	3.692
Falcon VI	190	1,425	180	2	1.895	1.404	3.299
Eagle VI	190	1,475	170	2	1.789	1.356	3.145
Gull VI	190	1,575	170	2	1.789	1.270	3.059

* Estimated.

Large Machines.		Small Machines.	
Peregrine	5.863	Falcon	6.415
Rapide	5.228	Merlin	5.792
D.H.86	4.663	Phœnix	5.073
Envoy	3.513	Vega Gull	4.502

[Although it does not matter greatly when one is comparing aircraft fitted with this engine, it should be pointed out that both Mr. Bentley in his original article and Mr. Brown in the above letter have taken the maximum power of the Gipsy Six as 190 b.h.p. Actually, it is 200 b.h.p. Consequently, the "commercial efficiency" of machines fitted with this engine is shown as slightly too high when compared with aircraft fitted with other engines.—ED.]

THE INDUSTRY

Accuracy in Aluminium

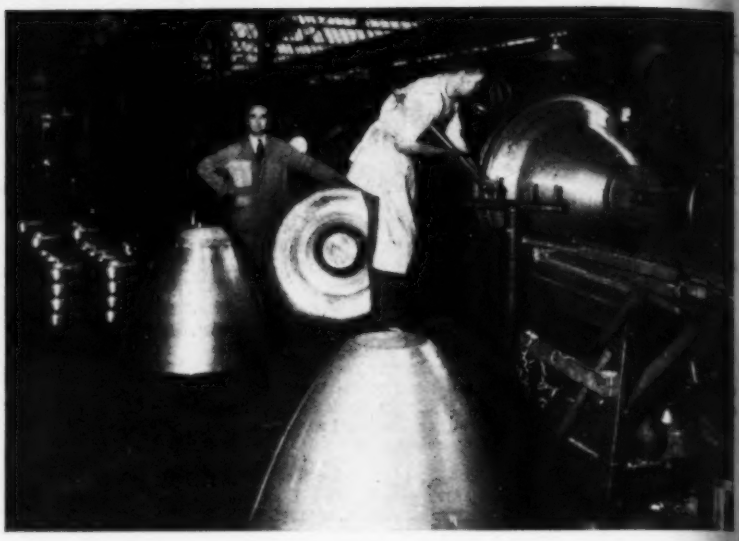
THE illustration on this page is particularly interesting, for it shows an aspect of aircraft-component manufacture with which many people, even in the industry, are not very familiar—namely, the production of sheet-metal pressings and spinnings, which, of course, play a most important part in modern aeroplane construction.

The photograph was taken in the Westwood Road, Birmingham, works of the London Aluminium Co., Ltd., aluminium specialists, where there is scarcely a single job demanding the employment of sheet metal that cannot be tackled and completed successfully. Pressings and spinnings of very many descriptions and sizes are produced, and the degree of accuracy obtained is, in many cases, remarkable for this class of work, overall limits as close as three thousandths of an inch presenting no difficulties.

Venturi tubes are among the most accurate items turned out in single spinnings, while the bigger jobs include nose and other cowlings, and tube mandrils for aircraft wheels.

Some large presses are being installed, and an indication of the work that can be done may be gained from the fact that sheet aluminium one inch in thickness is handled. In order to secure greater uniformity in repetition work, all small hand presses are being replaced by pneumatic presses.

A large extension is being added to the factory, and the anodising plant is being almost doubled. Other activities are spot welding and chromium plating of aluminium.



NOSE PIECES : One of the many sheet-aluminium components manufactured, as related on this page, by the London Aluminium Co., Ltd., of Birmingham.

Desford Aerodrome

THE En-Tout-Cas Co. (Syston), Ltd., wish it to be emphasised that, as reported in *Flight* of December 19, they were responsible for the surfacing of Desford Aerodrome.

Ultra-short Waves

IT now appears that among the work to be undertaken by the recently formed company, Aeronautical and General Instruments, Ltd., will be the development of ultra-short wave radio and its utilisation for aircraft control purposes.

A Record Year

C. C. WAKEFIELD & CO., LTD., the makers of the famous Castrol lubricants, report a record year of sales following the introduction of "Patent Castrol." Apart from the intrinsic quality of their products, they attribute much of this success to their vigorous Press advertising campaign.

Carburetter Company's Appointment

THE firm of H. M. Hobson (Aircraft and Motor) Components, Ltd., announces the appointment of three additional directors. They are Mr. Stanley Walter Hughes (sales director), Mr. James Montgomerie (works director), and Capt. Edward Dodson (technical director), who have been actively engaged with Hobson concern for 32, 25 and 15 years respectively.

A New Post

IT is announced that Flt. Lt. N. M. S. Russell has been appointed aviation representative to the Vacuum Oil Co., Ltd. He will be in charge of sales of the new range of Aero Mobiloil.

Flt. Lt. Russell has extensive flying experience, dating from the war days and covering almost the whole of Europe and the Near East. Since his retirement from the Service in 1928 he has been with Imperial Airways, has been test pilot and general manager to the Redwing Aircraft Company, chief instructor to the Surrey Aero Club and air superintendent to the Scottish Motor Traction Company; when that company closed down its aviation department he ran his own flying school, which eventually became the Edinburgh Flying Club.

The Hillson Praga

ALL correspondence regarding the Hillson Praga monoplane (described in *Flight* last week) should be addressed to F. Hills and Sons, Trafford Park, Manchester, who are now in a position to appoint agents.

Reading Appointments

IT is announced that Wing-Cdr. F. W. Stent, M.C., who has just retired, at his own request, after nearly twenty-one years' service in the Royal Air Force, has joined the sales department of Phillips and Powis Aircraft, Ltd.

Mr. L. Hackett has also been transferred to the sales department; he was originally responsible for the very efficient ground organisation of the Phillips and Powis Reserve School.

Specialised Bearings

FROM the war days onwards the Ransome and Marles Bearing Co., Ltd., have supplied special types of ball bearings to the aircraft industry, and their range is remarkable.—

To deal briefly with the types of interest to the industry, there is, first of all, a series of crankshaft ball and roller bearings in which every endeavour has been made to secure the lowest weight compatible with efficiency; whenever possible, in addition to reduction in the section of the bearing, the cages are made of duralumin.

Next there is a double-purpose ball bearing for rocker shafts and reduction gears, while a needle-type roller bearing has proved particularly suitable for camshafts, cam followers, etc.

Then there are special high-speed ball bearings for superchargers, made in light sections and manufactured to ultra-fine limits of accuracy, the duralumin cages being specially balanced. Probably the outstanding application is where a 2½in. bearing is run at a speed of from 25,000 to 30,000 r.p.m.

For resisting airscrew thrust there are single-row and double-row ball races of an extremely compact design. A special roller thrust bearing has also been developed for the blades of controllable-pitch airscrews.

In addition to their standard small ball races for use in control-surface hinges, etc., an especially light series has been developed, in which the section of the bearing is kept at an absolute minimum, thereby providing extreme freedom of movement at points where the speeds and loads are not abnormal, and with a considerable saving in weight and space. All control bearings are supplied in stainless steel or cadmium plated, while for particularly exposed positions, the bearings can be fitted with self-contained lubricant seals.

Another development which is shortly to take place is the supply of control pulleys, either die cast or made from fibre and fitted with single row bearings.